



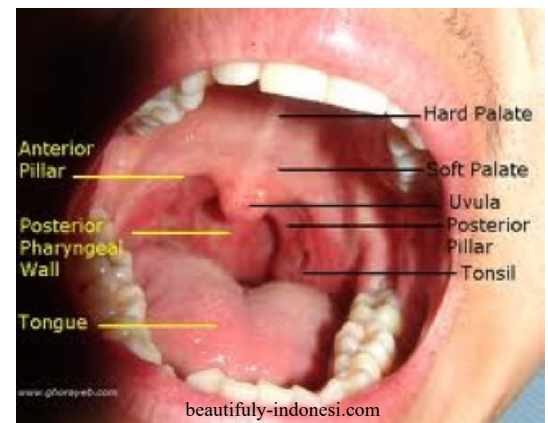
**ILOs: By the end of this lecture the student will be able to:**

1. Classify the types of oral mucosa.
2. Describe the structure of lining and masticatory mucosa.
3. Describe the structure of lip, tongue, palate and pharynx.
4. List the different types of lingual papillae.
5. Compare between the different types of tongue papillae
6. Describe the EM structure of taste buds.
7. Correlate the altered microscopic structure of the oral mucosa to the occurrence of different diseases.

- All the structures in the oral cavity are lined with stratified squamous epithelium, which may be keratinized, or non-keratinized, depending on the location.
- The stratified squamous epithelium consists of basal layer of columnar cells, then several layer of polyhedral or polygonal cells that flattens as they go up. The superficial cells are flat squamous cells which undergo continuous desquamation. Renewal of this epithelium occurs due to mitosis of stem cells in the basal layer.
- Throughout the oral cavity, the epithelium contains transient antigen-presenting cells and rich sensory innervation.

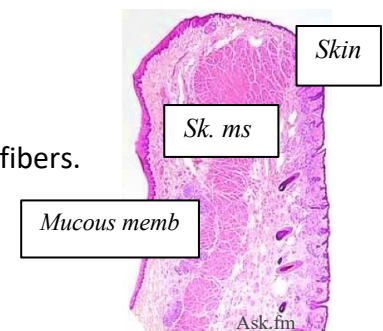
**Types of oral mucosa:**

- 1- Masticatory mucosa:** - in gingiva & hard palate (areas of friction).
  - Stratified squamous **keratinized**. Lying directly on periosteum.
- 2- Lining mucosa.** - In lips, cheeks, floor of mouth, soft palate & pharynx.
  - Stratified squamous **non keratinized** epithelium for protection.
  - Submucosa with minor salivary glands, and diffuse lymphoid tissue).
- 3- Specialized mucosa:** in dorsum of the tongue, forming lingual papillae that may contain taste buds.



**Structure of the Lip**

- **Outer Thin skin:**
  - Epidermis:** it is the stratified sq. keratinized epithelium of the skin.
  - Dermis:** Loose C.T. underneath the epidermis, with hair follicles, sebaceous gl. and sweat gl.
- **Orbicularis oris muscle:** A well-developed core of circular **skeletal muscle** fibers.
- **Internal mucous membrane:**
  - **Epithelium:** Thick stratified sq. non-k. ep. (*thicker than the thin skin*).
  - **Lamina propria:** loose C.T. containing labial glands (mainly mucous acini).



### **Vermilion zone (red margin):**

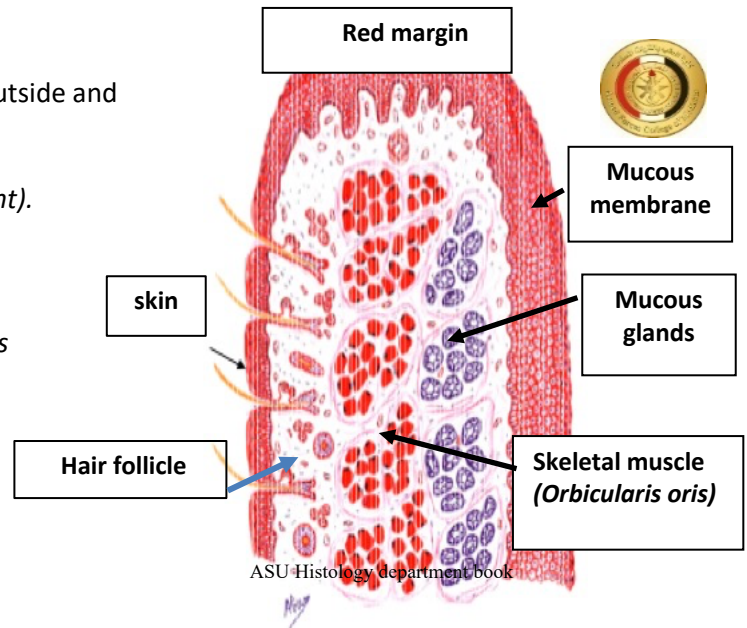
It is the transitional pink or red zone between the skin from outside and the mucous membrane from inside. It consists of:

#### **1- Modified skin**

- Very thin St. sq. keratinized ep. (hence, it is transparent).
- No sweat nor salivary glands.
- No hair follicles.
- No sebaceous glands.

#### **2- Numerous deep highly vascular dermal papillae (giving this a pink color) .**

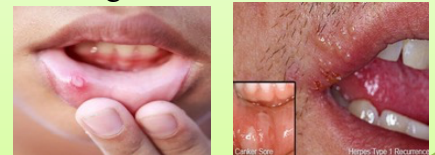
#### **3- Rich in nerves (hence, it is very sensitive).**



### **Clinical application:** **Canker & cold sores**

- These are painful, clustered vesicular or ulcerating lesions of the oral mucosa or skin near the mouth.
- In the oral cavity such areas are called canker sores (aphthous ulcers) and on the skin, they are usually called cold sores or fever blisters.
- The cold ulcers occur due to weak immune defenses due to emotional stress, fever, illness, or local skin damage, allowing the Herpes Simplex virus, present in local nerves, to move into the epithelial cells, resulting in death of infected cells

Medicinenet.com

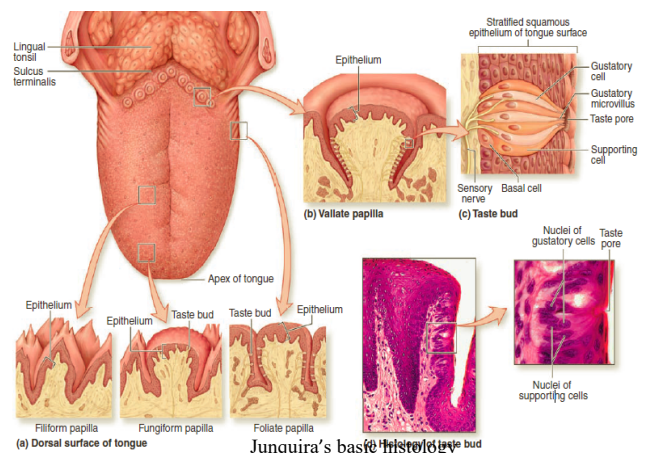


## **Structure of the Tongue**

**The tongue consists of two parts:**

- 1) The oral part:** it is the anterior 2/3 of the tongue. Covered by mucous membrane forming lingual papillae.
- 2) The pharyngeal part:** it is the posterior 1/3 of the tongue, contains the lingual tonsil.

*“Both parts are separated by a V-shaped groove called sulcus terminalis”.*





## Structure of the tongue:

### 1) Dorsal surface:

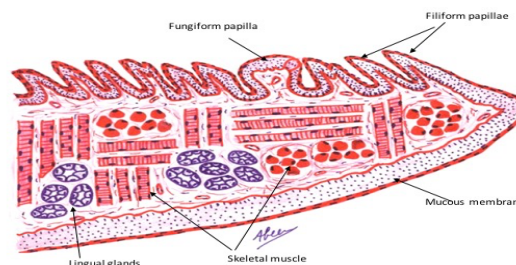
- Rough, shows lingual papillae anteriorly and lingual tonsils posteriorly, separated by the **sulcus terminalis**.

### 2) Striated muscle:

- Arranged in 3 **perpendicular** directions: longitudinal, transverse and vertical. So, it is very unique.

### 3) Ventral surface:

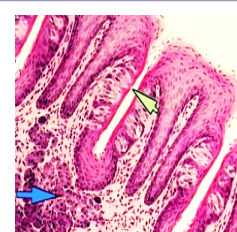
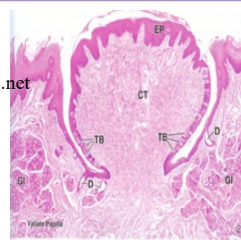
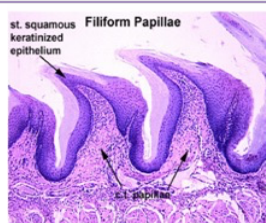
- It is a smooth surface, lined by st. sq. non keratinized epithelium, with **Lingual glands** (serous, mucous and mixed acini) underneath it.



## Lingual papillae

They are mucous membrane elevations including epithelium & lamina propria.

	Filiform p.	Fungiform p.	Circumvallate p.	Foliate p.
<b>Site</b>	-Numerous on ant. 2/3. of tongue.	-Few, scattered across the dorsal surface	<b>Largest</b> papillae, 8- 12 in number, lies in a V-shape just anterior to the sulcus terminalis.	More in young persons, and rudimentary in old age.
<b>Shape</b>	-Elongated conical shape with their tips pointing backwards.	Mushroom-shaped	Surrounded by <b>circular deep grooves</b>	-On sides the tongue
<b>Structure</b>	- Heavily keratinized giving the tongue giving grey or whitish appearance. - <b>No taste buds.</b>	-Lightly keratinized, well vascularized ( <b>red spots</b> ). - <b>Few Taste buds</b> on their upper surface.	Continuously flushed by the <b>serous</b> secretion of <b>Von Ebner's glands</b> . <b>Abundant taste buds</b> (250) on the lateral sides	-Several parallel ridges separated by deep grooves + Von Ebner's glands. <b>Numerous taste buds</b> on the sides.
	- Provides rough surface that facilitates food movement during chewing.	For taste sensation.	- For taste sensation. - <b>Lipase</b> enzyme <b>clear</b> the grooves by <i>(Prevents formation of a hydrophobic film that would hinder gustation)</i>	For taste sensation.



### Taste Buds



- They are a type of neuroepithelium located in different sites as: dorsal surface of the tongue, soft palate, pharynx, epiglottis.
- Structure: they are oval-shaped, rest on the basement membrane with an apical taste pore.
- Each taste bud is formed of:

#### 1- Neuro-epithelial cells (Gustatory cells):

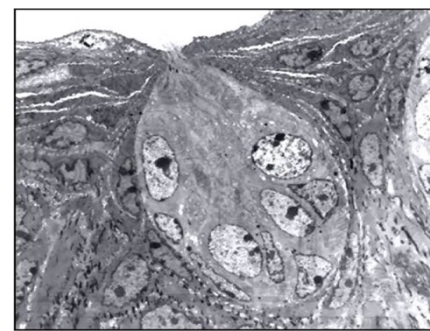
- Elongated columnar cells with apical microvilli projecting from the taste pore.
- Free nerve endings contact their basal surface.

#### 2- Supporting cells:

- Peripherally located elongated columnar cells.
- Support and secrete an amorphous material which surrounds the microvilli.

#### 3- Basal cells:

- Stem cells present near the base of the taste buds.
- They give rise to the other types of cells of the taste bud.



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- Their life span is about 7-10 days.

### Structure of the Palate

Hard Palate	Soft Palate
Anterior $\frac{2}{3}$ of roof	Posterior $\frac{1}{3}$ of roof
Immovable ( <b>Bone</b> )	Movable ( <b>skeletal muscles</b> )
Keratinized st. sq. epith adherent to bone	Inferior oral part is lined with st. sq. non-K. ep. Superior nasal part is covered with respiratory epith.

### Structure of the Pharynx

Nasopharynx	Oropharynx	Laryngopharynx:
Lined with pseudostratified ciliated columnar ep. with goblet cells.	Lined with stratified squamous non-kerat. ep	lined by stratified squamous non-keratinized ep.
Lamina propria contains pharyngeal tonsils.	Lamina propria contains palatine tonsils.	

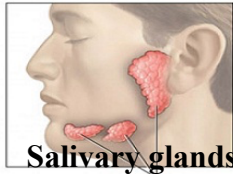
## Lecture 2: Histological Structure of Salivary glands



**ILOs: By the end of this lecture the student will be able to:**

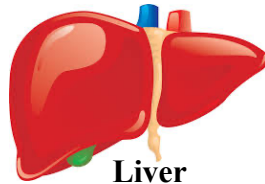
1. Classify different types of salivary glands.
2. Describe the structure of the major salivary glands: Stroma and Parenchyma.
3. Correlate between structure and function of the major salivary glands.
4. Compare between the structure of different types of salivary glands.

**There are three gut-associated glands:**



**Salivary glands**

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**Liver**

cdn.clipart.email



**Pancreas**

66.media.tumblr.com

### Structure of The Salivary Glands

**Main (major)**  
(3 paired glands)  
**Compound tubulo-alveolar**

- The parotid glands.
- The submandibular glands.
- The sublingual glands.

**Accessory (minor)**  
(Multiple & small)

They are groups of salivary glands having no capsules present in the lamina propria of the mucous membrane of the oral cavity.



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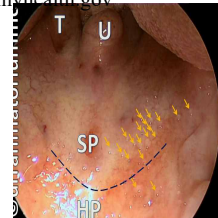
**Lingual glands**



**Labial glands**



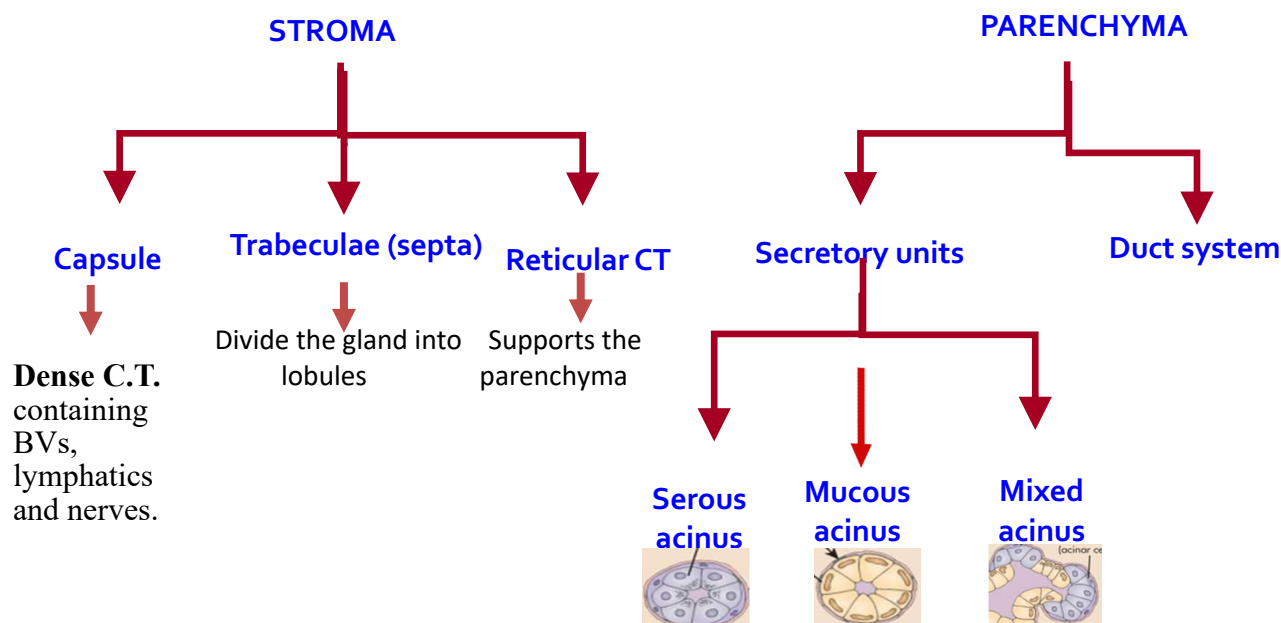
**Palatine glands**

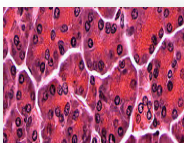
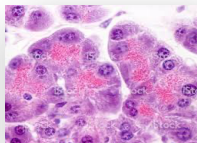
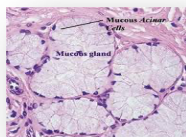
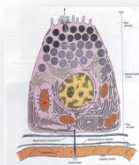
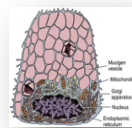


**Buccal glands**



Any major salivary gland consists of:



Serous acinus	Mucous acinus
<p><b>By LM:</b></p> <ul style="list-style-type: none"> <li>Small in diameter &amp; narrow lumen.</li> <li>Cells: <ul style="list-style-type: none"> <li>Vesicular, rounded basal nuclei.</li> <li>Basal basophilic cytoplasm.</li> <li>Apical acidophilic zymogen granules.</li> </ul> </li> <li>Surrounded by a few myoepithelial cells.</li> </ul> <div>   </div> <p><a href="http://www.siumed.edu/~dking2/erg/images/G1119b.jpg">http://www.siumed.edu/~dking2/erg/images/G1119b.jpg</a></p>	<p><b>By LM:</b></p> <ul style="list-style-type: none"> <li>Large diameter and wide lumen.</li> <li>Cells: <ul style="list-style-type: none"> <li>Flattened basal nuclei.</li> <li>Pale basophilic, foamy cytoplasm (due to dissolved mucinogen granules).</li> </ul> </li> <li>Surrounded by numerous myoepithelial cells</li> </ul> <div>  </div> <p><a href="s3.amazonaws.com">s3.amazonaws.com</a></p>
<p><b>By EM:</b></p> <p>Protein secreting cell characterized by:</p> <ul style="list-style-type: none"> <li>Abundant basal RER.</li> <li>Prominent supranuclear Golgi complex.</li> <li>Numerous membrane-bound spherical electron dense secretory granules (rich in amylase).</li> <li>Numerous mitochondria</li> </ul> <div>  </div> <p><a href="intranet.tdmu.edu.ua">intranet.tdmu.edu.ua</a></p>	<p><b>By EM</b></p> <p>Glycoprotein secreting cell characterized by:</p> <ul style="list-style-type: none"> <li>Basal RER</li> <li>Supra nuclear Golgi (greater carbohydrate component)</li> <li>Numerous membrane-bound electron lucent mucinogen granules.</li> <li>Mitochondria</li> </ul> <div>  </div> <p><a href="https://pocketdentistry.com">https://pocketdentistry.com</a></p>

**Mixed acinus:**

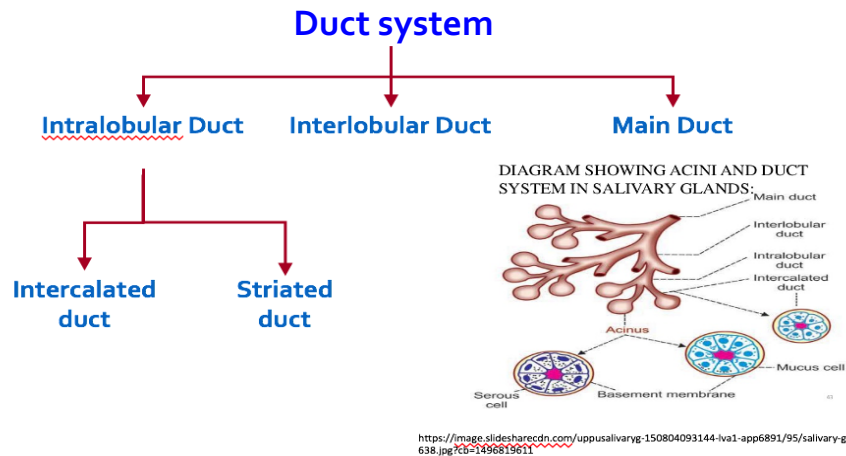
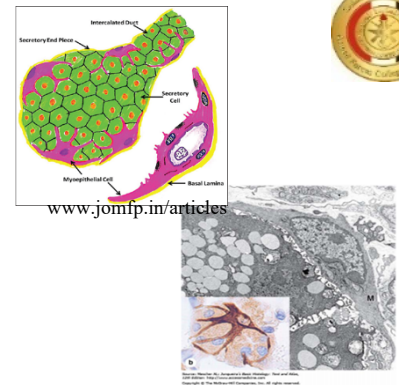
Formed of a mucous acinus which is capped by aggregation of serous cells





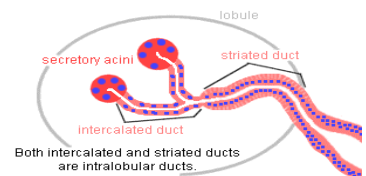
### Myoepithelial (basket) cells

- Contractile cells having actin and myosin.
- Numerous processes.
- Present between plasma membrane of secretory cells and basal lamina & form hemi-desmosomes with it.
- Also present around cells of proximal part of duct system.
- Function: movement of secretion toward ducts



### 1- The intercalated ducts:

- Are lined by cuboidal cells.
- Function: cells have the ability to divide and differentiate (*stem cells*) → into secretory or ductal cells.



### 2-Striated (Secretory) ducts:

- Lined by cubical or low columnar cells
- acidophilic granular cytoplasm, basal striation

By EM:

- Basal infoldings of cell membrane (contains Na-K ATPase)
- Basal mitochondria

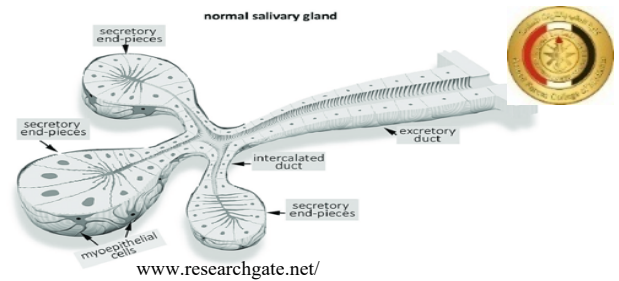


*Functions of the striated ducts:*

1. Modify the electrolytes of the secretion of the acini (forming secondary saliva).
2. Secretion of lysozymes which attack bacteria.
3. Transport of IgA secreted by the plasma cells present in the surrounding C.T. into its lumen.

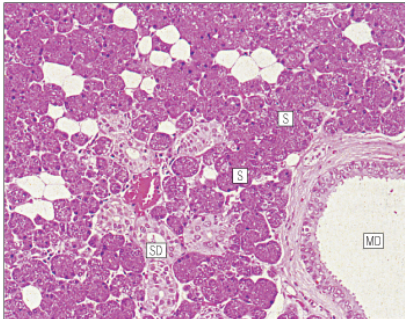
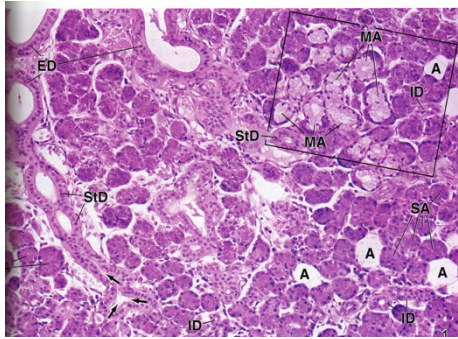
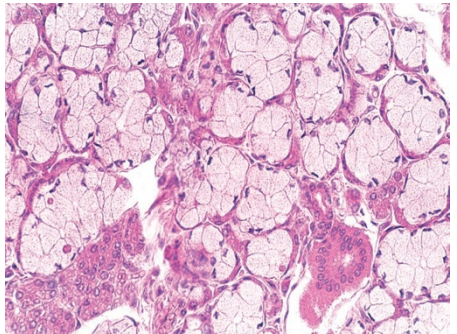
### 3- The inter lobular ducts:

- Small ducts → columnar
- larger ducts → pseudostratified columnar
- distal parts → stratified columnar epithelium.



### 4- The main duct of each major salivary gland:

- The proximal part is lined with → stratified columnar epithelium.
- The distal end is lined with → non-keratinized stratified squamous epithelium which ultimately open into the mouth cavity.

Parotid gland	Submandibular gland	Sublingual gland
Pure serous	Predominantly serous with few mucous and mixed acini	Predominantly mucous acini with some mixed acini.
Have a thick well-developed capsule and interlobular septa	Have a thick C.T. capsule and thin C.T. septa	-----
The septa contain fat, lymphocytes and plasma cells	The septa contain less fat cells.	-----
Prominent striated secretory ducts	Striated ducts are present	Striated ducts are present
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## The saliva



### Functions of saliva:

- Lubrication
- Taste sensation.
- Protective coat on teeth (proline rich proteins).
- Initial digestion (amylase)
- Antibacterial (Ig A & lysozyme)
- Wound healing (EGF & clotting F).



**ILOs: By the end of this lecture the student will be able to:**

1. Describe the structure of the different GIT layers.
2. Describe the LM picture of the esophagus.
3. Describe the altered microscopic structure of the esophagus in different diseases.

**All parts of the GIT tube consist of the following 4 layers:**

**a) Mucosa:**

- **Epithelial lining:** Two types according to its site & function
  - Esophagus & anus: St. sq. non K. Ep.
  - Stomach & intestine: Simple columnar ep
- **Lamina propria:** Loose connective tissue containing lymphatic tissue (**G**ALT) + **G**lands.
- **Muscularis mucosa.** Smooth muscle arranged in 2 layers: Inner circular & outer longitudinal

**b) Submucosa: C.T.** Connective tissue containing :

- Large blood vessels, lymphatics
- **M**eissner's plexus of nerves.
- **G**lands in esophagus, duodenum only.

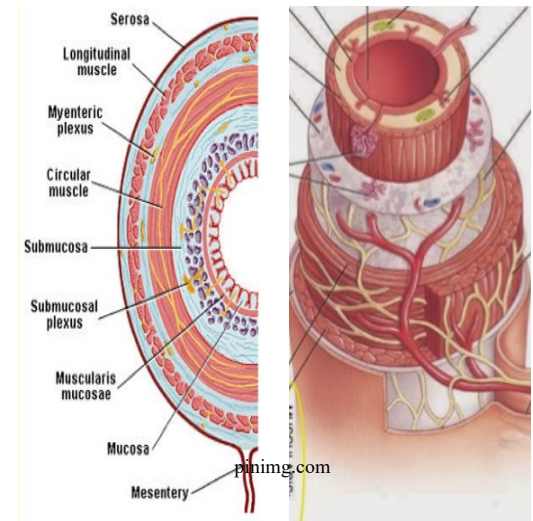
**c) Muscularis externa:** Smooth muscles arranged in 2 or more layers (for peristalsis):

- Inner circular layer, mix the lumen content (by constricting the lumen).
- Outer longitudinal layer, propels food (by shortening the tube).
- Auerbach's nerve plexus (myenteric plexus) between both layers.

**N.B.:** Meissner's and myenteric plexuses constitute the enteric nervous system

**d) Serosa or adventitia:**

- Adventitia: it is a C.T. layer (for Fixation to surrounding).
- Serosa: loose C.T. covered by peritoneum (mesothelium) to give a smooth surface, not fixed to surroundings.



## Structure of Esophagus

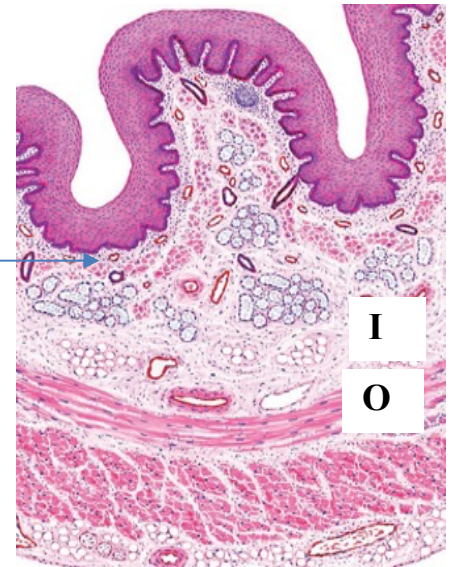


### a) Mucosa:

- **Epithelial lining:** St. sq. non K. Ep.
- **Lamina propria:** Loose connective tissue containing Small **GALT** + mucous secreting **Glands**:
  - In Upper part : to lubricate & protect the mucosa.
  - In lower part: **cardiac gland** to protect from backflow of HCL.
- **Muscularis mucosa:** Inner circular (IC) & outer longitudinal (OL) Smooth muscles.

### b) Submucosa: C.T. Connective tissue containing :

- **Meissner's** plexus of nerves.
- Mucous **Glands**



### c) Muscularis externa:

- Inner circular layer, Outer longitudinal layer.
- Types:**
  - **Upper third** → skeletal muscle fibers.
  - **Middle third** → mixture of smooth & skeletal muscle fibers.
  - **Lower third** → smooth muscle fibers
- Auerbach's nerve plexus (myenteric plexus) between both layers.

### d) Serosa or adventitia:

- Esophagus is covered by **adventitia** **EXCEPT** below the diaphragm, about 2 cm of esophagus is covered with **serosa**.

**Clinical application:**  
**Reflux esophagitis & Barrett esophagus**

The lubricating mucus produced in the esophageal submucosal glands offers little protection against acid that may come from the stomach.

So, if there is incompetent lower esophageal sphincter

Movement of acids & pepsin from the stomach to the esophagus

**heartburn or reflux esophagitis**

if untreated

**Barrett esophagus**

“Metaplasia of epithelium from st.sq.non.kerat. to simple columnar with goblet.....salmon pink areas”



## Lecture 4: Structure of the Stomach



### By the end of this lecture the student will be able to:

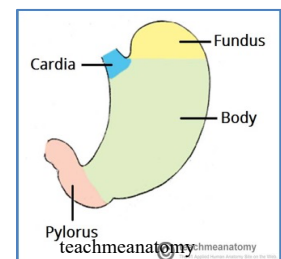
1. Describe the structure of the fundus and pylorus.
2. Enumerate cells lining fundic and pyloric glands.
3. Describe the LM and EM structure and correlated functions of the cells lining the fundic and pyloric glands.
4. Correlate the structure of fundus of stomach to its function.
5. Describe the altered microscopic structure of the fundus of stomach in different diseases.
6. Compare between the structure of fundus and pylorus of stomach.
7. Describe the protective mechanisms of gastric mucosa.
8. Describe the epithelial cell renewal in gastric mucosa.

### **Remember these cells' general characteristics**

Stem cells	Mucous secreting cells	Protein secreting cells
<ul style="list-style-type: none"> <li>• <b>LM:</b> Basophilic cytoplasm, vesicular nucleus.</li> </ul>	<ul style="list-style-type: none"> <li>- Pale basal basophilia</li> <li>- Apical pale basophilic foamy cytoplasm full of mucinogen granules (<b>PAS positive</b>).</li> <li>- Vesicular nucleus.</li> </ul>	<ul style="list-style-type: none"> <li>- Deep basal basophilia.</li> <li>- Apical acidophilic zymogen granules.</li> <li>- Basal vesicular nucleus</li> </ul>
<ul style="list-style-type: none"> <li>• <b>EM:</b>-Abundant free ribosomes - Little Golgi, mitoch, rER</li> </ul>	<ul style="list-style-type: none"> <li>- Small basal rER</li> <li>- Supranuclear Golgi.</li> <li>- Mitochondria.</li> <li>- Apical electron lucent granules</li> </ul>	<ul style="list-style-type: none"> <li>- Well-developed basal rER</li> <li>- ↑Supranuclear Golgi</li> <li>- Abundant mitochondria.</li> <li>- Apical electron dense granules.</li> </ul>

### The stomach is divided into:

1. **Cardia:** near the esophageal orifice, contains the cardiac glands.
2. **Fundus:** the anatomical fundus + body, contain the fundic (gastric) glands.
3. **Pylorus:** proximal to the pyloric sphincter and contain pyloric glands.



## Structure of fundus of stomach

The mucosa of the stomach appears greyish pink in color, thrown into folds called **rugae** (*mucosal and submucosal branching longitudinal folds*)

These rugae help in expansion of the stomach in different directions to act as a reservoir of food ..... so, they are **not permanent**

The gastric epithelium is invaginated deeply into the lamina propria to form **gastric pits (foveolae)**. From the bottom of pits several gastric glands extend downward, occupying the greater part of the thickness of the mucosa.

**The fundus is composed of the four usual layers:**

**I- Mucosa:** it is formed of:

- Surface mucous secreting epithelium.
- Lamina propria containing **simple tubular fundic glands**
- Muscularis mucosa: IC, OL
- Gastric pits form  $\frac{1}{4}$  of the thickness of the mucosa.

**Surface mucous secreting epithelium:** Simple columnar epithelium

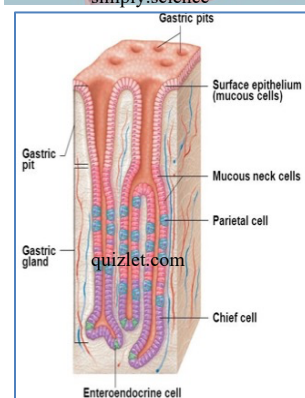
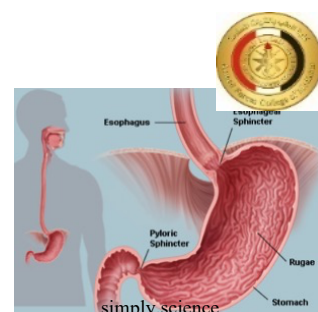
- **Site:** Lines the surface and gastric pits
- **LM:** Nucleus: basal oval,  
Cytoplasm: pale basophilic, apical PAS positive mucin granules
- **EM:** Small rER, Golgi apparatus, mitochondria, apical secretory granules.
- Secrete **thick, adherent, highly viscous, visible mucous**, have cloudy appearance, **rich bicarbonates** (highly alkaline mucous), forms a **gel coat** to **protect** mucosa from HCL in intraluminal food.

**II- Submucosa:** c.t. with small blood vessels + Meissner's plexus.

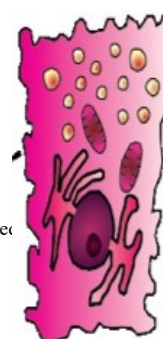
**III- Muscularis externa:** (3 layers)

- Innermost **oblique** smooth ms
- Middle circular smooth ms.
- Outer longitudinal smooth ms.
- + Auerbach's plexus of nerves.

**IV- Serosa.**

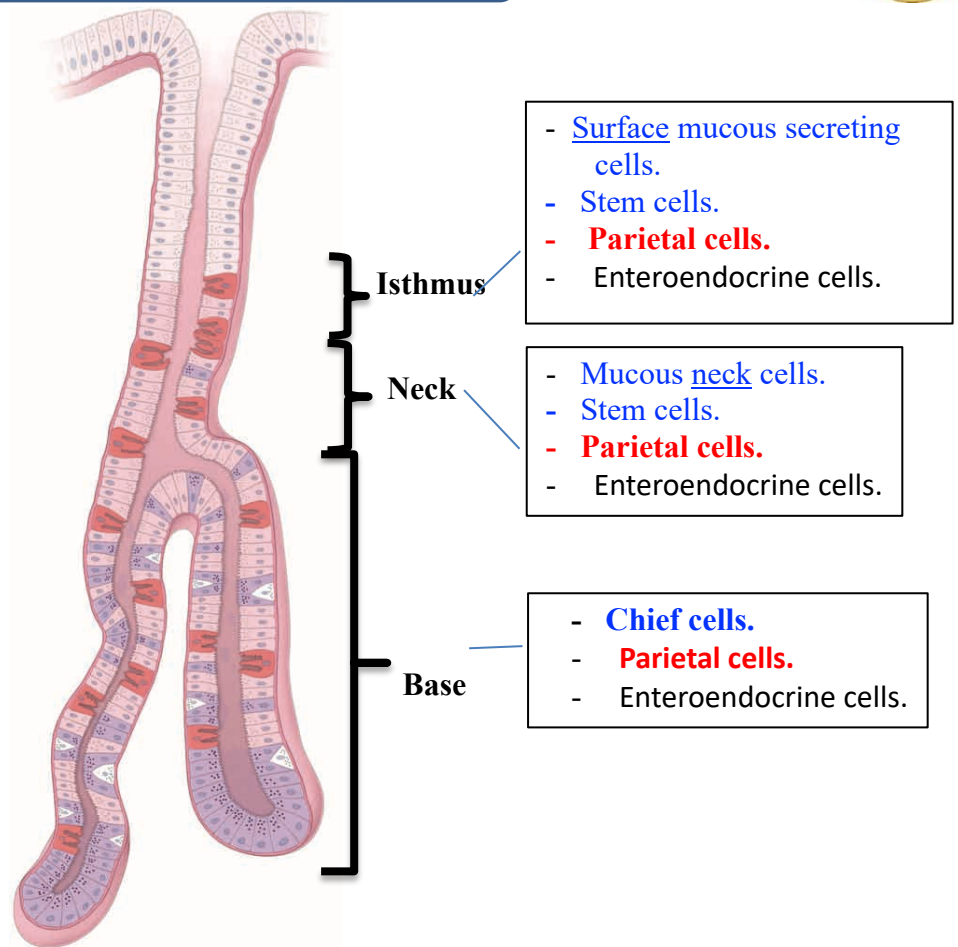


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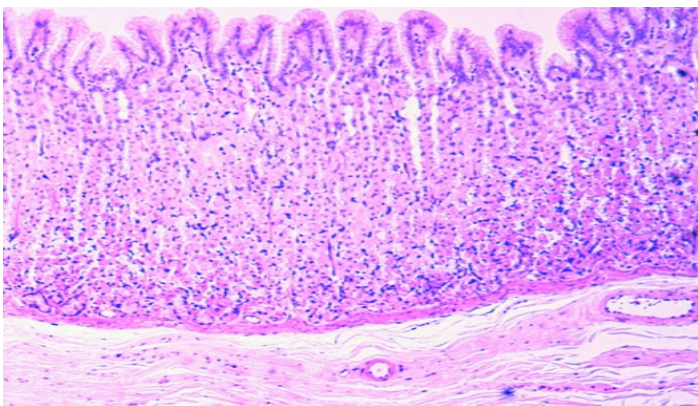


in rough

## Fundic (gastric) glands



- Simple branched tubular
- Narrow lumen.
- Perpendicular to the surface & open to the surface by gastric pits (ducts).
- Each gastric gland is divided into 3 regions: Isthmus, neck & base.

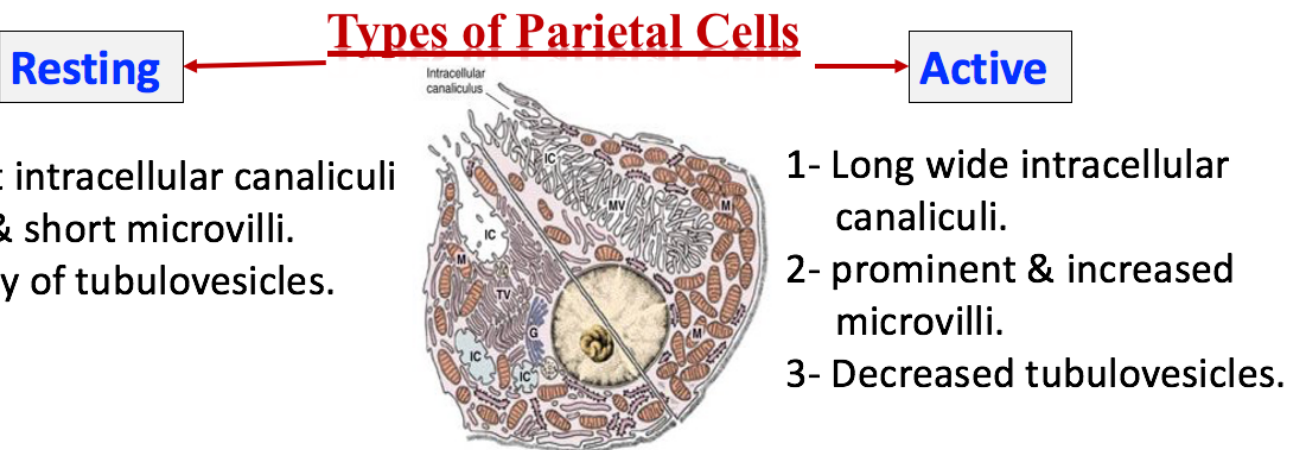
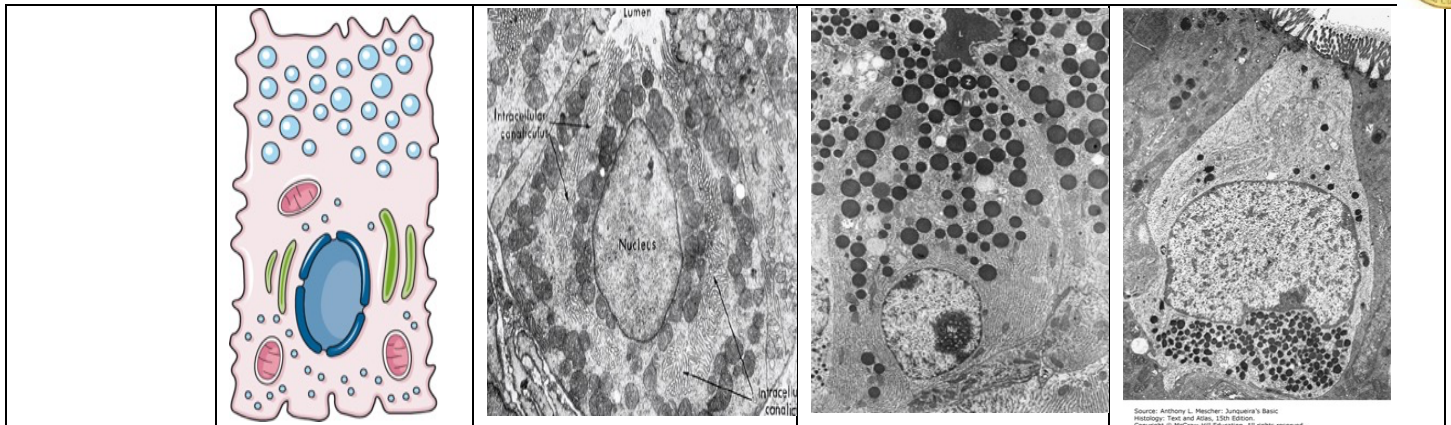


### Cells of Fundic (gastric) glands



Stem cells	Mucous neck cells	Parietal (Oxyntic) cells	Chief (zymogenic) cells	Enteroendocrine cells
<b>Site:</b> isthmus (stem cell niche).	Neck region of fundic gland	In upper half of gastric glands (mainly in neck), fewer in the base.	<b>Base</b> of fundic gl.	Scattered.
<b>LM:</b> Basophilic cytoplasm.  Vesicular nucleus	Apical pale basophilic foamy mucinogen granules <b>(PAS positive).</b> ( <i>less than surface mucous cells</i> ).	- Rounded or pyramidal. - <b>Deeply acidophilic</b> - Nucleus: rounded central vesicular, may be binucleated	Cytoplasm: basal deep basophilia, apical acidophilic zymogen granules - Nucleus: rounded, basal, vesicular	Not well distinguished by H&E  Seen by <b>silver</b> (argentaffin cells), <b>chromium</b> (enterochromaffin cells), and by <b>immunohistochemistry</b>
<b>EM:</b> abundant <u>free ribosomes</u> ,  little Golgi, little mitochondria, .....	- Well-developed basal rER, Golgi apparatus  - Apical secretory vesicles.	- <b>Abundant mitochondria</b> (giving the acidophilia in LM). - <b>Intracellular canaliculi:</b> deep invagination of the apical plasma membrane that shows <b>microvilli</b> . - <b>Tubulovesicular system</b> surrounding the canaliculi, acting as a reservoir. - Little RER, small Golgi complex	- Apical secretory zymogen granules Supranuclear Golgi complex Abundant basal rER - Abundant mitochondria	<b>2 types:</b>  <b>Open type:</b> reach the lumen and have apical microvilli (chemoreceptors).  <b>Closed type:</b> do not reach the lumen.  Both have <b>basal secretory granules</b> .
Have a high rate of <b>mitosis</b> -----renewal and repair of the epithelium of gastric mucosa.	Secrete <b>soluble mucous, less alkaline</b> than the surface mucous secreting cells to intermingle with the stomach content.	<b>HCL &amp; intrinsic factor secretion</b>	secrete <b>pepsinogen</b> ( <i>activated by acidity of stomach into <b>pepsin</b></i> ), and  <b>+ lipase</b> enzyme.	Secrete different hormones, affecting the gut motility, secretion of HCL, proliferation of stem cells, ....so, they have different names (EC cells , ECL cells, ....)





Junqueira's Basic Histology; Text and Atlas. 14<sup>th</sup> edition 2016

***Tubular vesicles fuse with the plasma membrane (helped by actin) to elongate the intracellular canaliculi with more microvilli, thus giving → increased surface of the plasma membrane for HCL & intrinsic factor secretion***

Clinical application:  
**Pernicious**  
**anaemia**

It is a type of anemia caused by damage to parietal cells secondary to atrophic gastritis or autoimmune disease.

secretion of insufficient quantities of intrinsic factor → inadequate absorption of **vitamin B12** → Impaired DNA synthesis → Decrease proliferation of erythroblasts

Clinical application:  
**Carcinoid**  
**tumors**

They are tumors arising from **enteroendocrine EC cells**.

Overproduction of serotonin.

Increases gut motility &  
Mucosal vasoconstriction and tissue damage.

## Structure of pylorus of stomach



**I- Mucosa:** thinner than that of the fundus, consists of :

- 1- simple columnar mucous secreting epithelium (also lines the pits).
- 2- Lamina propria containing the pyloric glands
- 3- muscularis mucosa: as fundus; IC and OL

The pyloric glands are simple branched **coiled** tubular glands that are widely separated from each other.

**Gastric pit:**

- wide and deep, taking  $\frac{1}{2}$  the thickness of the mucosa
- Coiled secretory portions mostly cut in T.S. and oblique sections.

**Pyloric glands are lined by:**

- a) Mucous secreting cells
- b) Stem cells
- c) Enteroendocrine cells.

**II- Submucosa:** smaller than in fundus

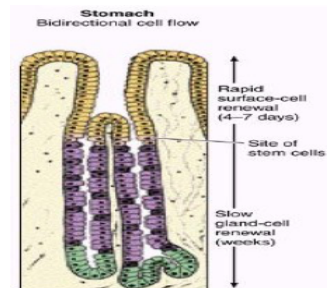
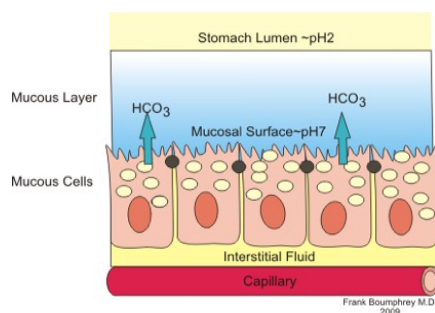
**III- Musculosa:**

- Very thick inner circular smooth m. forming the **pyloric sphincter**.
- Outer longitudinal smooth ms.

**IV- Serosa**

## Protective mechanism of gastric mucosa

- Thick coating of viscid mucus secreted by surface epithelial cells
- Continuous Renewal of gastric mucosa, due to mitotic activity of stem cells in isthmus of fundic glands..... **Renewal rate of epithelial lining is about 4-7 days**





	Fundus	Pylorus
<b>Mucosa</b>	Contain fundic glands: <ul style="list-style-type: none"> <li>- simple branched tubular</li> <li>- numerous</li> <li>- perpendicular to surface</li> <li>- narrow lumina</li> <li>- narrow gastric pits</li> </ul> -Gastric pits form $\frac{1}{4}$ of thickness of mucosa -lined by surface mucous cells, mucous neck cells, parietal cells, chief cells, stem cells, enteroendocrine cells	Contain pyloric glands: <ul style="list-style-type: none"> <li>- simple branched tubular <u>coiled</u></li> <li>- less numerous</li> <li>- not perpendicular to surface, secretory portions are cut in T.S. &amp; oblique sections</li> <li>- wide lumina</li> <li>- wide deep gastric pits</li> </ul> - Gastric pits form <u><math>\frac{1}{2}</math></u> the thickness of mucosa -lined by mucous secreting cells, stem cells & enteroendocrine cells
<b>Submucosa</b>	c.t.	c.t.
<b>Muscularis externa</b>	3 layers: <ul style="list-style-type: none"> <li>- <u>inner oblique</u>,</li> <li>- middle circular</li> <li>- outer longitudinal smooth muscle</li> </ul>	2 layers: - inner circular (greatly thickened) forming pyloric sphincter - Outer longitudinal
<b>Serosa</b>	present	present

**Clinical application:**  
**Gastric ulcer**

It is a painful erosive lesion of the **mucosa** that may extend to deeper layers. Such ulcers can occur anywhere between the lower esophagus and the jejunum

- Causes:**
- Overproduction of HCl or pepsin.
  - Lowered production of mucus or bicarbonate.
  - Bacterial infections with *Helicobacter pylori*
  - Effects of nonsteroidal anti-inflammatory drugs (NSAIDs).



**By the end of this lecture the student will be able to:**

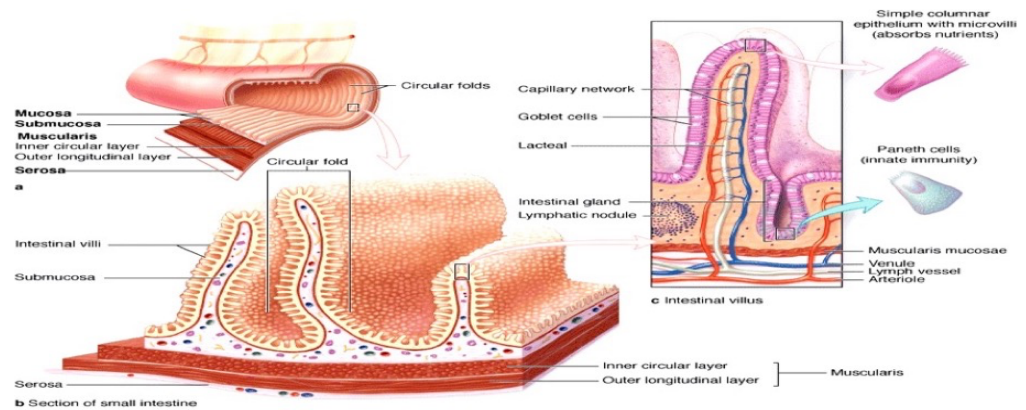
1. Describe the general structure of small intestine.
2. Enumerate cells covering the villi.
3. Correlate the LM & EM structure of enterocytes and goblet cells to their functions.
4. Correlate the altered microscopic structure of the small intestine to the occurrence of diseases.

**The surface area of the lining of small intestine is increased by:**

- 1- Plicae circulares (valves of Kerckring) (x3)
  - They are permanent circular or semilunar folds consisting of mucosa and submucosa, seen by naked eye
- 2- Villi (x10).
- 3- Microvilli (x20).



Plicae circulares



Villi

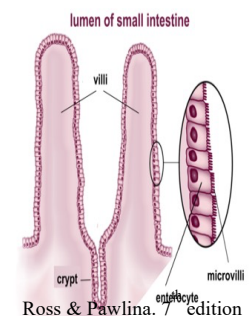
- The small intestine consists of three parts: duodenum, jejunum and ileum
- All share the general histological characteristics with few modifications.

### General structure of small intestine

**1- Mucosa:**

It is characterized by the appearance of:

- **Villi:** Finger like mucosal projections above the surface, covered by simple columnar epithelium.
  - They give a velvet-like appearance by naked eye.
- **Simple tubular glands (Crypts of Lieberkühn)** that invaginate into the C.T. corium occupying its whole thickness (*every villous is followed by one crypt*).



Ross & Pawlina. 7<sup>th</sup> edition



**Mucosa consists of:**

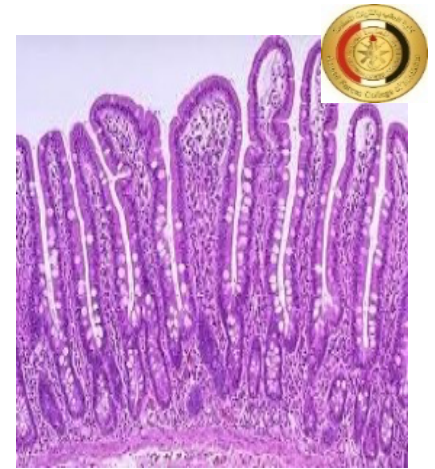
- a- **Epithelial lining:** simple columnar epith. cover the villi & line the crypts.
- b- **Lamina propria:** Loose C.T., forming the cores of the villi and filling the spaces between the crypts. It is very rich in blood capillaries, lymphocytes, Plasma cells & macrophages.
- c- **Muscularis mucosa:** smooth muscle : (I.C, O.L).

**2. Submucosa:**

Dense C.T. containing blood vessels, lymphatics and Meissner's plexus  
+  
Brunner's glands (in duodenum),  
Peyer's patches (in ileum).

**3. Muscularis externa:** IC, OL. + Auerbach's nerve plexus in-between.

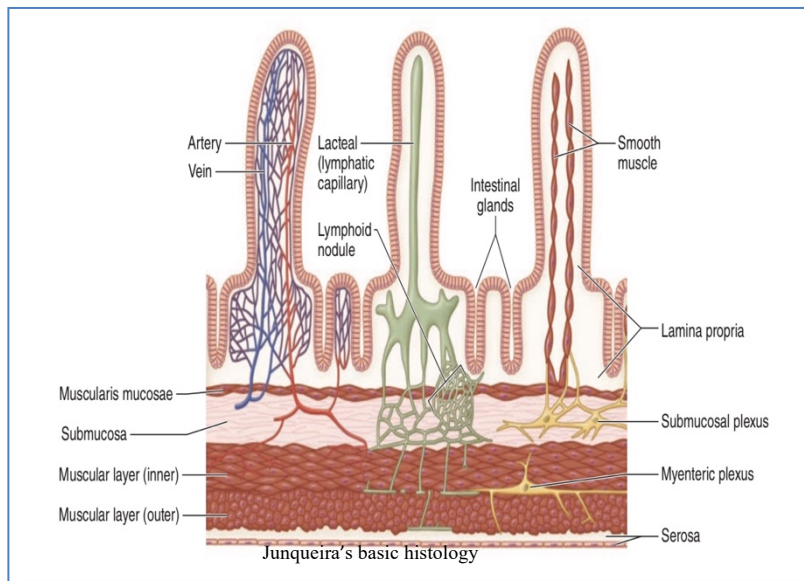
**4. Serosa.**



**Small intestinal villi**

**The core of the villus is formed of:**

- 1) **Loose C.T.:** Extending from the lamina propria, containing lymphocytes, plasma cells and macrophages.
- 2) **Central lymphatic lacteals:** help in fat absorption.
- 3) **Smooth muscle fibers:** extend from Muscularis Mucosa to surround the lacteals. They extend up to the tip of the villus.
- 4) **Fenestrated blood capillaries:** Take away the nutrients (absorbed food) to the circulation.





### The cells covering the villi are:

1. Absorptive columnar cells (Enterocytes).
2. Goblet cells.
3. Enteroendocrine cells.

### *1- Columnar absorptive cells (Enterocytes)*

**Site:** Present over the villi & upper parts of the crypts.

**LM:** - Tall Columnar cells with apical brush border  
(Striated border, PAS+ ve).  
- Acidophilic cytoplasm and basal oval nuclei

### **TEM:**

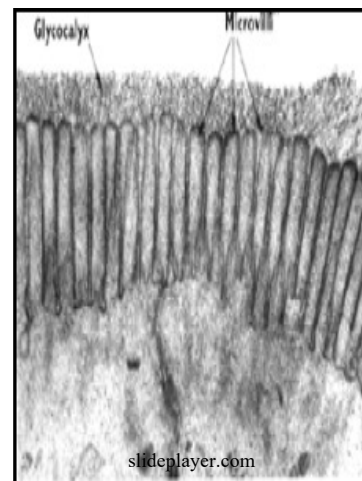
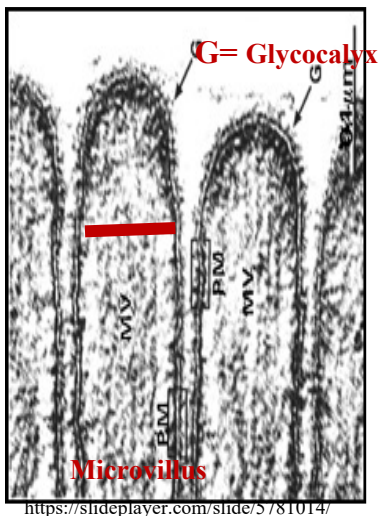
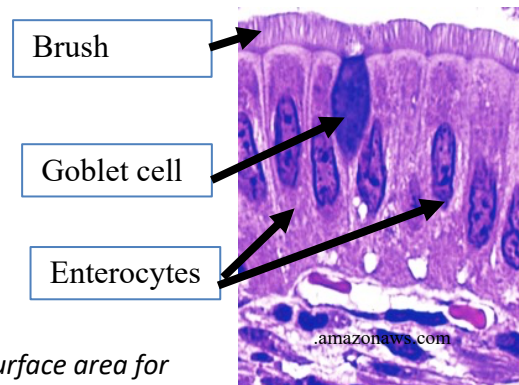
- Numerous Apical microvilli (3000/cell, to increase the surface area for absorption).

They contain **actin filaments** and covered by cell membrane and **glycocalyx (cell coat)**.

↓  
inserts into "the terminal web"  
(a network of horizontally oriented actin filaments in the apical cytoplasm).

↓  
contains **Brush border enzymes** (dipeptidases & disaccharidases)

↓  
Terminal digestion of proteins into a.a. & CHO into monosaccharides, that are easily absorbed

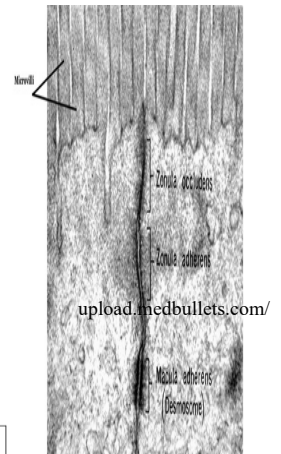


- **Junctional complex** between adjacent cells, consisting of zonula occludens (ZO; tight junction), zonula adherens (ZA) and desmosomes.

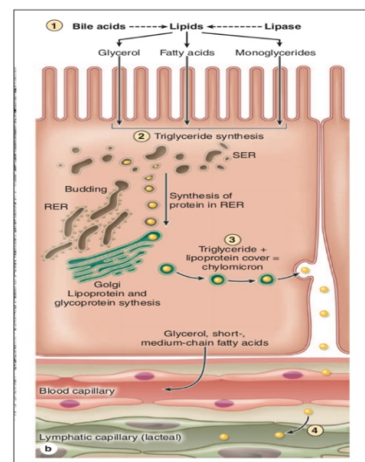
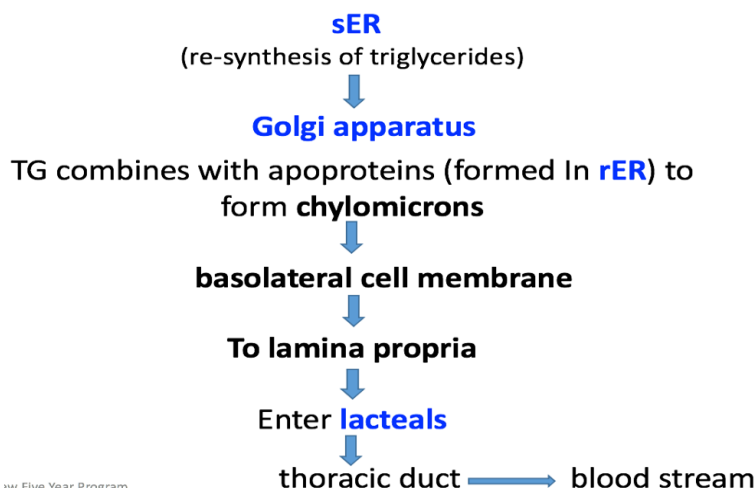


*The **tight junctions (ZO)** regulate the paracellular movement (i.e. regulate passage of material through the intercellular space to or from the lumen of the gut).*

- **Lateral plications (interdigitation)** are present below the junctional complex to increase the surface area for fat absorption.
- **rER, Golgi & many mitochondria** (for synthesis of brush border enzymes).
- **sER** (for re-synthesis of triglycerides).



### Organelles involved in fat absorption



Junqueira's Basic Histology: Text and Atlas, 14th edition 2016. 17

Clinical application:

### Lactose intolerance

Occurs in some infants and in adults

**Absence of lactase enzyme** from the microvilli membrane (i.e. from enterocytes brush border)

Inability to split lactose (milk sugar) into galactose & glucose

Bloating and diarrhea on consuming milk

May be alleviated upon elimination of lactose from the diet or consuming lactose-free milk or lactase tablets

### Celiac disease

- **Cause:**

Immune reaction against gluten, which is found in wheat which affects **enterocytes brush border (loss of microvilli)** and destruction of villi.

- It is associated with malabsorption, diarrhea and abdominal pain.

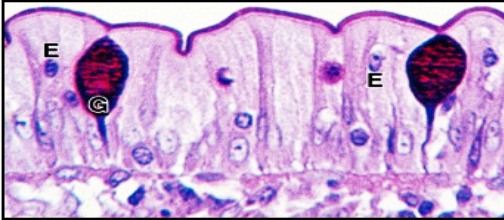


## 2- Goblet cells

**Site:** Between the enterocytes over the villi & in the upper parts of the crypts.

**L.M: [Unicellular gland]**

- Distended apical pale basophilic, vacuolated cytoplasm (due to dissolved mucinogen granules, PAS +ve).
- Oval vesicular nucleus in the narrow basal part



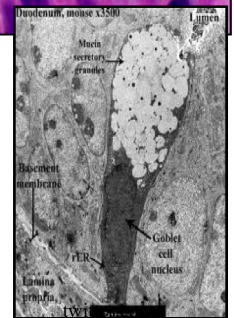
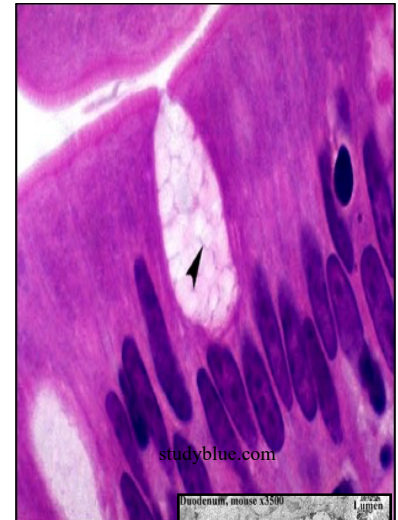
Both brush border & Goblet cells give +ve PAS reaction

**E.M.:** Supranuclear Golgi, rER & mitochondria.

**Function:** Secrete glycoprotein mucins, that are then hydrated to form mucus, for protection and lubrication

**N.B.**

The duodenum has the smallest number of goblet cells. The goblet cells number increases toward the ileum.





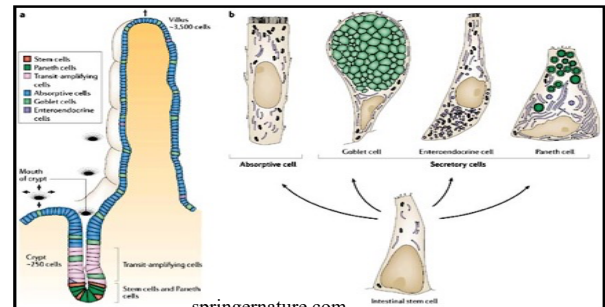


**By the end of this lecture the student will be able to:**

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### Cells lining the Small intestinal crypts

- 1- Columnar absorptive cells (Enterocytes).
- 2- Goblet cells.
- 3- Enteroendocrine cells.
- 4- Paneth cells.
- 5- Crypt base columnar cells (Undifferentiated stem cells).
- 6- Membrane-like epithelial cells (M Cells).

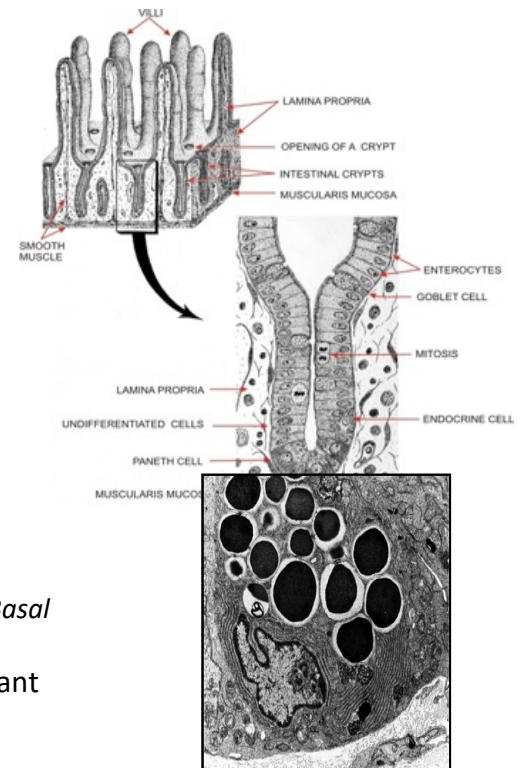


### Crypt base columnar cells

- They are **Stem cells** found mainly at the **base of the crypts**.
- **LM:** Basophilic cytoplasm, Vesicular nucleus
- **EM:** abundant free ribosomes, little Golgi, little mitochondria.
- **Renewal rate** of enterocytes and goblet cells = 4-6 days
- They divide in the crypts and reach the villous surface within one day.
- The epithelial cells migrate to the tip of the villous, then become lost into the intestinal lumen.

### Paneth cells

- **Site:** Present in groups, at the base of crypts only [below the stem cells].
- **Protein secretory cell**
- **LM:** (Deep basal basophilia, Apical acidophilic zymogen granules, Basal vesicular nucleus).
- **EM:** Well-developed basal rER, ↑Supranuclear Golgi, Abundant mitochondria, Apical electron dense granules.
- **Functions:** - Secretion of 1) Lysozymes (anti-bacterial).  
2) Defensin proteins.  
- Regulate the bacteria flora of intestine



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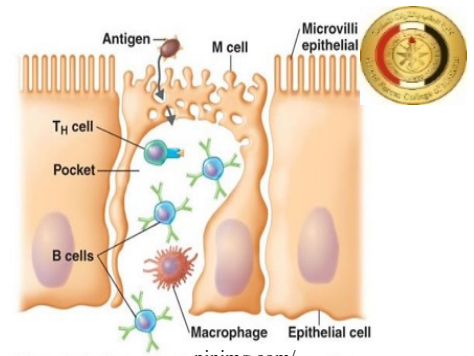
## Microfold Cells (M cells) (*Membrane-like cells*)

**Site:** Between the epith. cells of ileum overlying Peyer's patches.

**L.M.:** Cannot be distinguished because they are very thin & stretched.

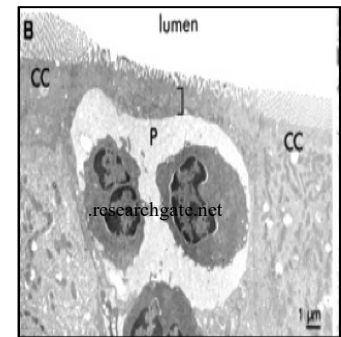
### EM of M cells:

- Free borders: Show Small number of microvilli.
- Basal parts: show numerous basal membrane invaginations, forming pockets (p) containing intraepithelial lymphocytes & macrophages.
- Lateral borders: joined with the neighboring columnar cells (CC) by junctional complexes.
- Cytoplasm: contains few lysosomes.



(b) M cells facilitate contact between antigens passing through the intestinal tract and cells of the body's immune system.

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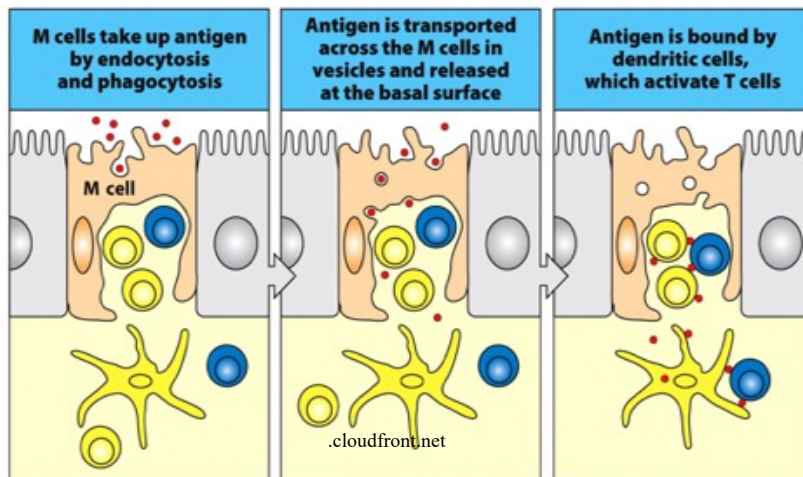
**Function:** They are Antigen transporting cell. (Immune surveillance)

They phagocytose antigens [*present in the intestinal lumen*] ➡ Transports them across the cytoplasm ➡

➡ Antigens bind to the underlying lymphocytes & macrophages

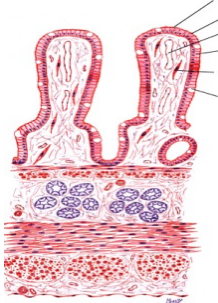
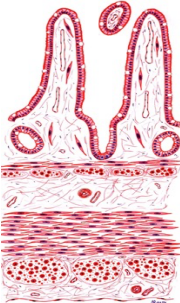
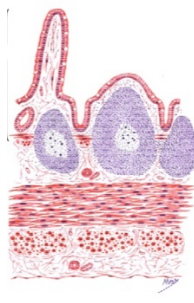
These cells migrate to mesenteric lymph nodes to initiate immune response.

### Antigen uptake and presentation by M cells



## Histological Differences between different parts of small intestine



	<b>Duodenum</b>	<b>Jejunum</b>	<b>Ileum</b>
<b>Villi</b>	<b>Broad &amp; <u>numerous</u></b>	<b>Long</b>	<b><u>Least in number</u></b> <i>villi are short or absent over The Peyer's patches</i>
<b>Goblet cells</b>	<b>Few</b>	<b>More</b>	<b><u>Numerous</u></b>
<b>Submucosa</b>	<b>Broad &amp; Contains Brunner's glands</b>	<b>-----</b> <i>just c.t. with Meissner's plexus as usual</i>	<b>Peyer's patches</b>
			

### Brunner's glands of

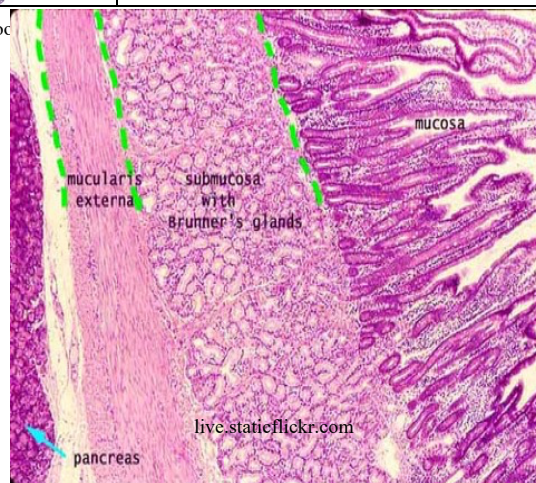
ASU-Histology department boc

They are submucosal mucous acini in duodenum only.

Secrete a Mucous Alkaline fluid that:

- 1) Helps neutralize the acidic chyme thus protecting the duodenal lining.
- 2) Maintains PH for pancreatic enzymes

### Peyer's patches of ileum



- Large aggregates of Lymphatic nodules present in the **submucosa of ileum**.
- Only on the **anti-mesenteric border**.
- Considered as one of the GALT (immune defense).
- They may penetrate the MM & reach the lamina propria of the mucosa.
- The villi over Peyer's patches are **short or absent**.
- The epithelial covering of these patches contains **M cells**.



### **Structure-function adaptation of small intestine**

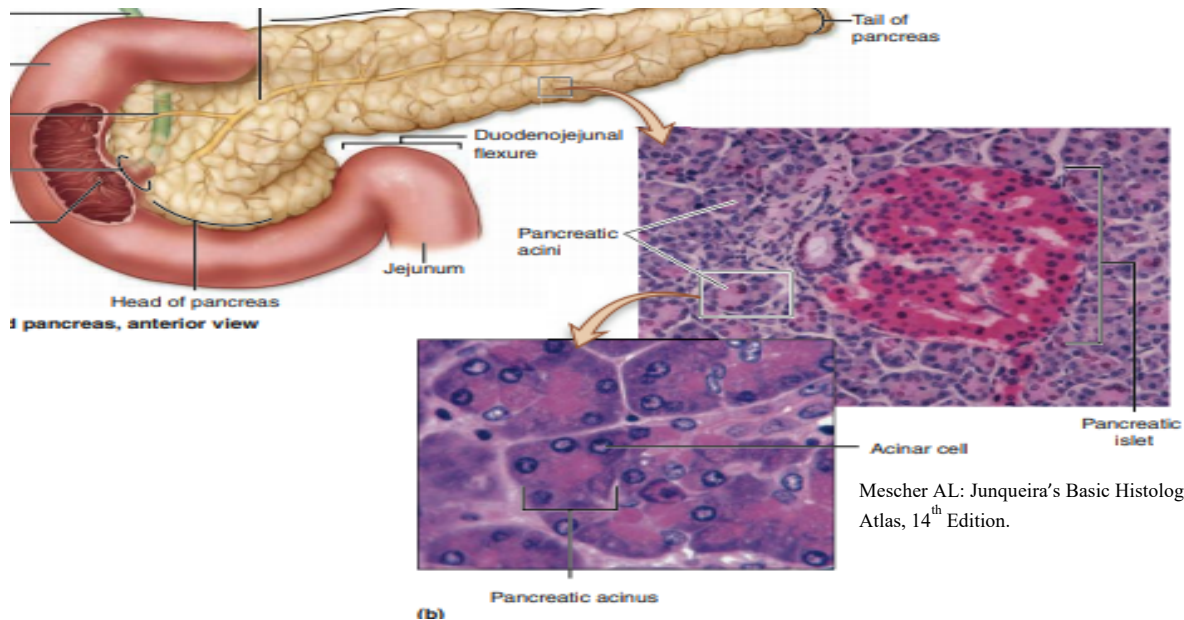
- A. Brush border of enterocytes :** contain Dipeptidases and disaccharidases
- B. sER in enterocytes:** for re-synthesis of TG during fat absorption process.
- C. Intestinal Crypts of Lieberkuhn:** secrete enzymes, hormones & mucus.
- D. Submucosal glands:** Mucus-secreting Brunner's glands in duodenum.
- E. Increase surface area for absorption:**
  - 1. Intestinal length: 5 meters.
  - 2. Plicae Circulares [Valves of Kerckring].
  - 3. Intestinal villi
  - 4. Microvilli
- F. Immunological Function:** M cells & Peyer's Patches.

## Lecture 7: Structure of the Exocrine Pancreas

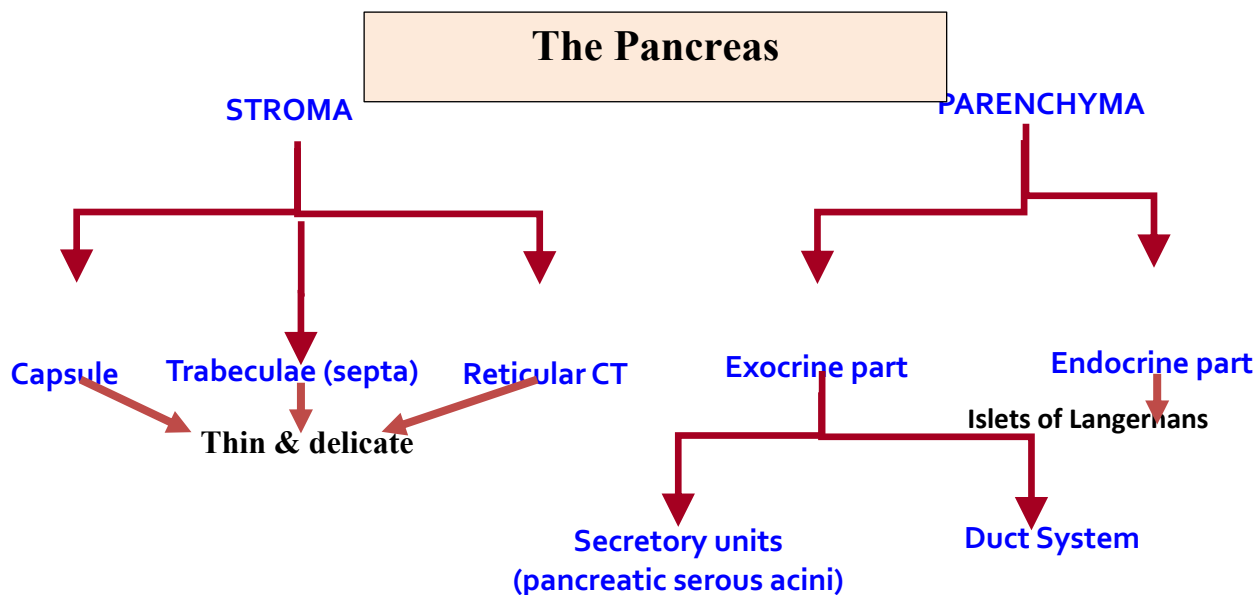


**By the end of this lecture the student will be able to:**

- 1) Describe the structure of the exocrine part of the pancreas.
- 2) Correlate the structure of the exocrine pancreas to its function.
- 3) Compare between the structure of the parotid gland and the pancreas.



The pancreas is the second largest gland in the body. it is a mixed gland with an exocrine part secreting digestive enzyme and an endocrine part that secrete hormones.





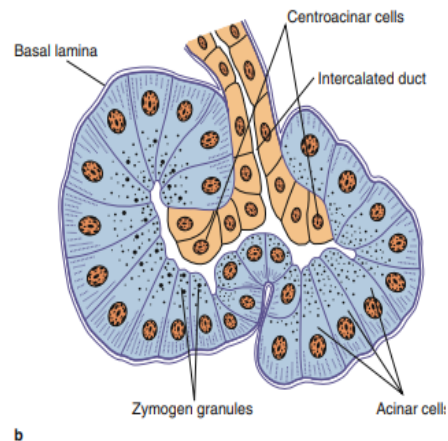
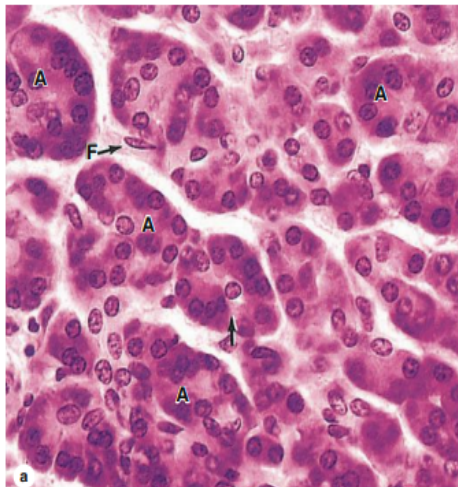
## Pancreatic serous acini



- They resemble the serous acini of the parotid gland except that they have centroacinar cells in their lumen and have no myoepithelial cells:

### LM:

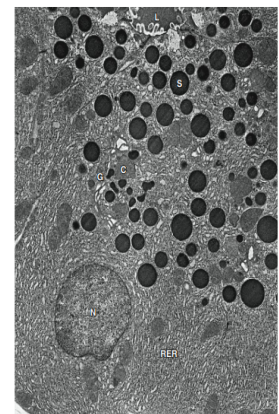
- Pyramidal cells arranged around a central lumen.
- Nucleus is spherical, basal & vesicular.
- Cytoplasm: basal basophilic striations.
- Apical acidophilic large zymogen granules
- The lumen contains centroacinar cells
- No myoepithelial cells



Mescher AL: Junqueira's Basic Histology: Text and Atlas, 14<sup>th</sup> Edition.

### EM:

- Basal rER.
- Elongated basal mitochondria.
- Supranuclear well developed Golgi apparatus.
- Apical zymogen granules (inactive enzymes).
- Junctional complexes between acinar cells to protect them from the secreted digestive enzymes.



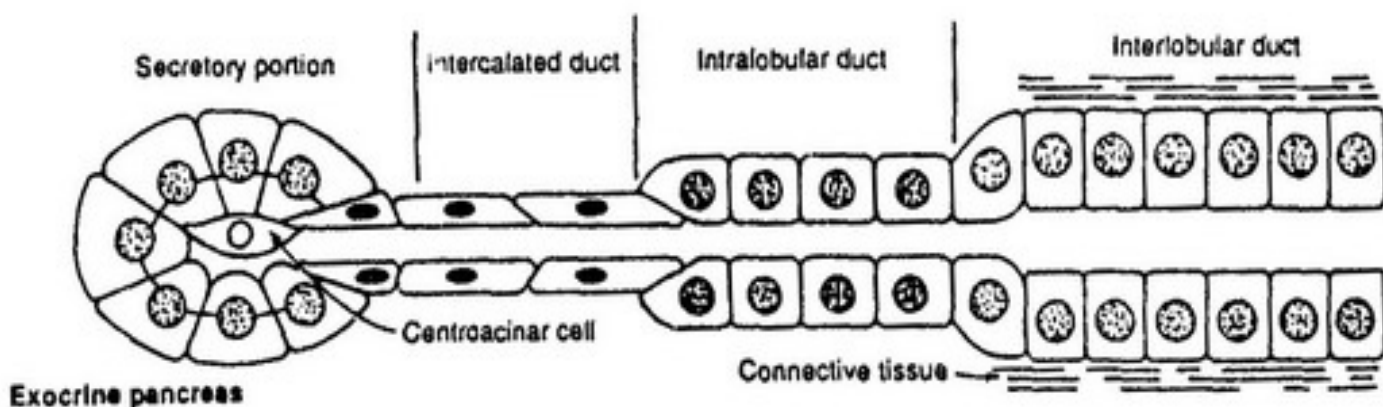
Mescher AL: Junqueira's Basic Histology: Text and Atlas, 14<sup>th</sup> Edition.





## Pancreatic duct system

- Centro acinar cells } Secrete alk. rich fluid by secretion
- Intercalated ducts }
- Intralobular collecting duct.
- Interlobular ducts
- Main & Accessory Pancreatic ducts (Simple columnar, EEC & goblet cells)



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### Function of exocrine pancreas:

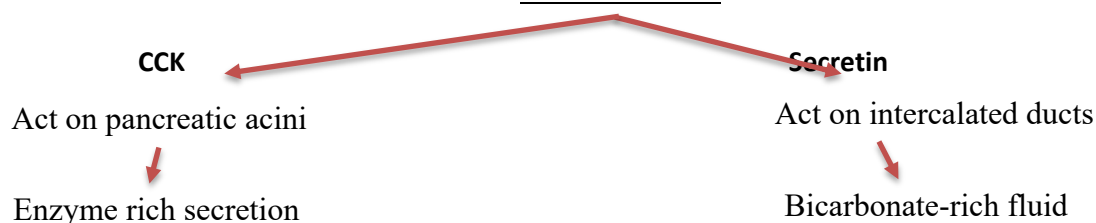
- Secretion of amylase, lipase, ribonuclease and elastase.
- Secretion of proenzymes: trypsinogen and chymotrypsinogen (become activated after reaching the duodenum as there is alkaline medium made by the secretion of Brunner's glands).
- Bicarbonate rich buffer solution.

### Mechanism of protection against autodigestion of pancreas

- 1- Pancreatic enzymes are stored in inactive forms & activated only in the duodenal mucosa by enterokinase.
- 2- Cytoplasm of acinar cells contains trypsin inhibitor

### Secretion of pancreatic enzymes is under nervous and hormonal control:

- Para-sympathetic stimulates secretion.
- Hormonal control: from intestinal enteroendocrine cells:



### Clinical application:

## Acute pancreatitis

The proenzymes may be activated and digest pancreatic tissues, leading to very serious complications. Possible causes include infection, gallstones, alcoholism, drugs, and trauma.



	<b>PANCREAS</b>	<b>PAROTID</b>
<b>Capsule</b>	Thin	Thick
<b>Trabeculae</b>	Thin and loose	Thick and fibrous
<b>Acini: Serous</b>	Larger and variable shape Centro-acinar cells	Smaller and rounded Absent
<b>Ducts</b>	Relatively few	Numerous
<b>Striated duct</b>	Absent	Numerous
<b>Main duct</b>	Simple Col, Enteroendocrine cells & goblet cell	St sq.non ker.
<b>Islets of Langerhan's</b>	Present	Absent

	<b>parotid</b>	<b>Sublingual</b>	<b>submandibular</b>	<b>Pancreas</b>
<b>Secretory acini</b>	Pure serous	predominantly mucous	predominantly serous	Pure serous but larger acini
<b>Centro-acinar cells</b>	Absent	Absent	Absent	Present
<b>Intercalated duct function</b>	Stem cells	Stem cells	Stem cells	Secretin ---- bicarbonate rich fluid
<b>Striated duct</b>	Numerous	Numerous	Numerous	Absent
<b>Main duct</b>	stratified columnar epithelium. The distal end is lined with → non-keratinized stratified squamous epithelium			Col, EEC & goblet cell
<b>Myoepithelial cells</b>	Less Numerous	Numerous	Less Numerous	Absent

## Lecture 8: Structure of the Large intestine



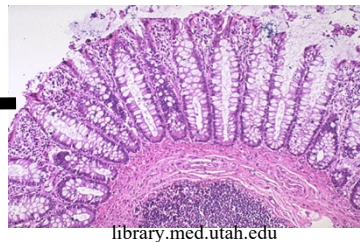
### By the end of this lecture the student will be able to:

1. Describe the histological structure of the different parts of large intestine & anal canal.
2. Correlate the structure of different parts of large intestine and anal canal to their functions.
3. Compare between the structure of appendix and colon.
4. Compare between the structure of appendix and ileum.
5. Describe the histological changes occurring at the recto-anal junction.
6. Interpret the involved histological structure of the colon and anal canal in different diseases.

## Structure of cecum & colon

### 1- Mucosa

- Thrown into folds.
- No villi - Crypts are deep & wide.



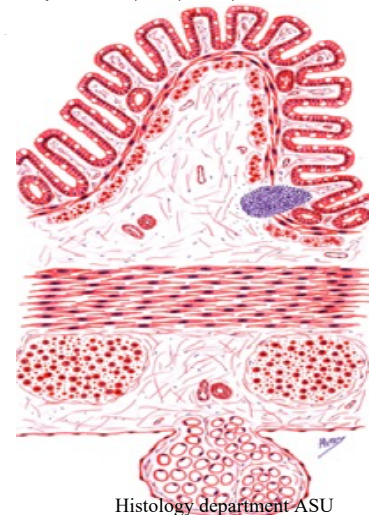
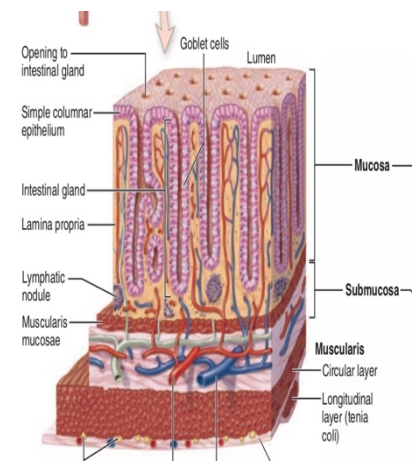
#### a) Epithelial lining:

- Simple columnar epith.
- Cells as small intestine, but NO Paneth, NO M cell:
  - Absorptive Columnar cells (colonocytes).
  - Numerous Goblet cells.
  - Few Enteroendocrine cells.
  - Stem cells: at base of the crypts

**b) Lamina Propria:** C.t. occupied by crypts + rich in lymphatic nodules (d.t. presence of many bacteria).

**c) Muscularis Mucosa** (IC, OL).

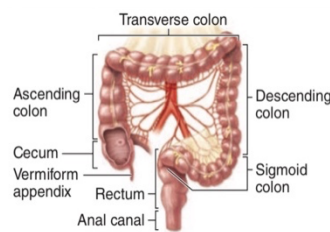
**2- Submucosa:** No glands. Meissner's plexus is present as usual.



Histology department ASU

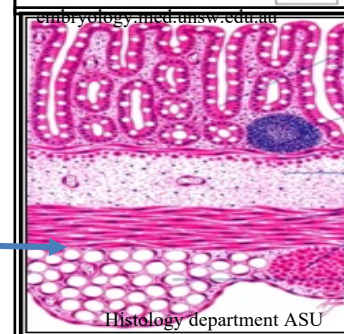
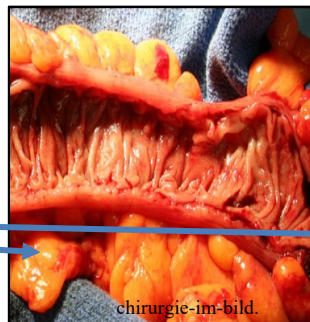
### 3- Musculosa:

- IC, OL.+ Myenteric plexus
- The outer longitudinal layer is not continuous , present in 3 bundles or bands called Taenia Coli (ribbons of the colon) making the haustra of large intestine (pouches).



### 4- Serosa

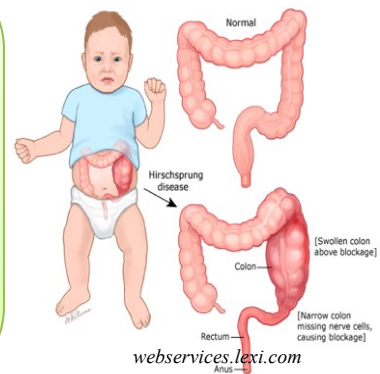
- Formed of C.T. rich in fat cells, covered with peritoneum (simple squamous mesothelium).
- Accumulation of adipose cells beneath the peritoneum forms pouches called appendices epiploicae.



CELL	COLONOCYTES	GOBLET	ENTEROENDOCRINE	STEM CELL
<b>LM</b>	Acidophilic cytoplasm brush border, basal oval nucleus	Wide apex, narrow base, basal basophilia and vacuolated apical part	Need silver stain, chromium stain or immunostaining	- Columnar - present in base of the crypt - Basophilic cytoplasm
<b>EM</b>	Mitochondria, sER, rER, Golgi complex.  - Irregular microvilli - Junctional complex  - Dilated intercellular spaces.	Basal part contains rER, Golgi complex, mitochondria  Apical secretory mucous granules	-Two types: closed and open.  - It contains rER, Golgi complex , mitochondria and basal secretory granules	- Free ribosomes - Little other organelles.
<b>function</b>	Water absorption	Secrete mucous to lubricate feces	Secrete hormones	Regeneration of different cells

Clinical application:  
**Congenita**  
**I**  
**megacolon**

Absent or destructed enteric nervous system  
(*Meissner's and myenteric plexuses*) →  
Disturbs digestive tract motility & produces  
dilations in some areas



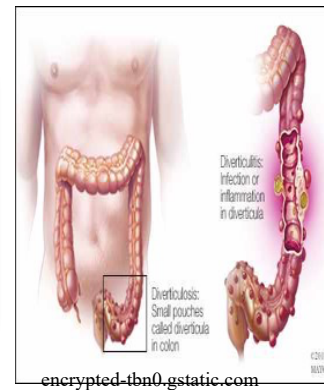
**Diverticulosi**

**S**

It is a case of herniation or out pocketing of the **mucosa and submucosa** of the colon between the taenia coli, forming bulges (diverticula).

Causes:

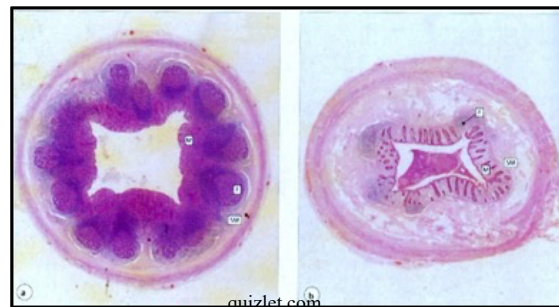
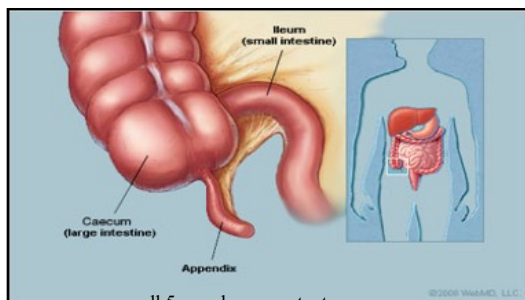
- Structural defects in the colon wall
- High intraluminal pressure
- Constipation



**Structure of vermiform appendix**

• **Definition:**

- Small, worm-shaped diverticulum arising from caecum, 2-8 cm in length.
- Same structure of large intestine, with some modifications





## 1- Mucosa

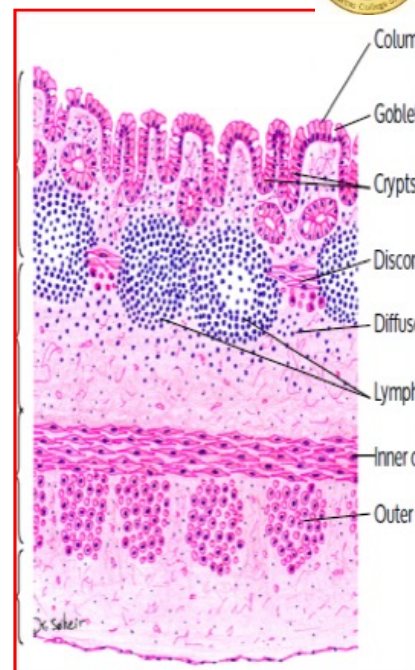
- a) **Epithelial lining:** simple columnar epithelium
- No Villi
  - Crypts are irregular, very short and fewer in number, lined with cells as in large intestine (fewer goblet cells).
- b) **Lamina propria (C.T. corium):** Loose C.T., rich in lymphoid nodules, that may extend deep to submucosa.
- c) **Muscularis mucosa:** Poorly developed, may be absent

## 2- Submucosa: Rich in lymphatic nodules

## 3- Musculosa

- Thin IC, OL
- (NO Taenia coli). Continuous outer longitudinal smooth muscle

## 4- Serosa: NO Appendices epiploicae.



### Ileum

Villi + Crypts.

### Appendix

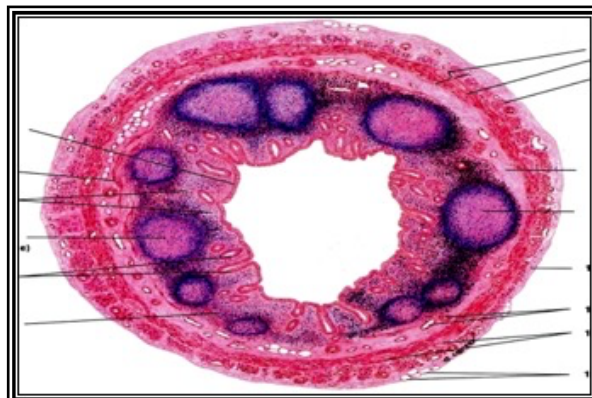
Crypts ONLY.

Lymphatic Nodules: Only on the anti-mesenteric border



<https://classconnection.s3.amazonaws.com/686/flashcards/1590686/png/picture31339381029705-thumb400.png>

Lymphatic Nodules: All around



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## Structure of the rectum

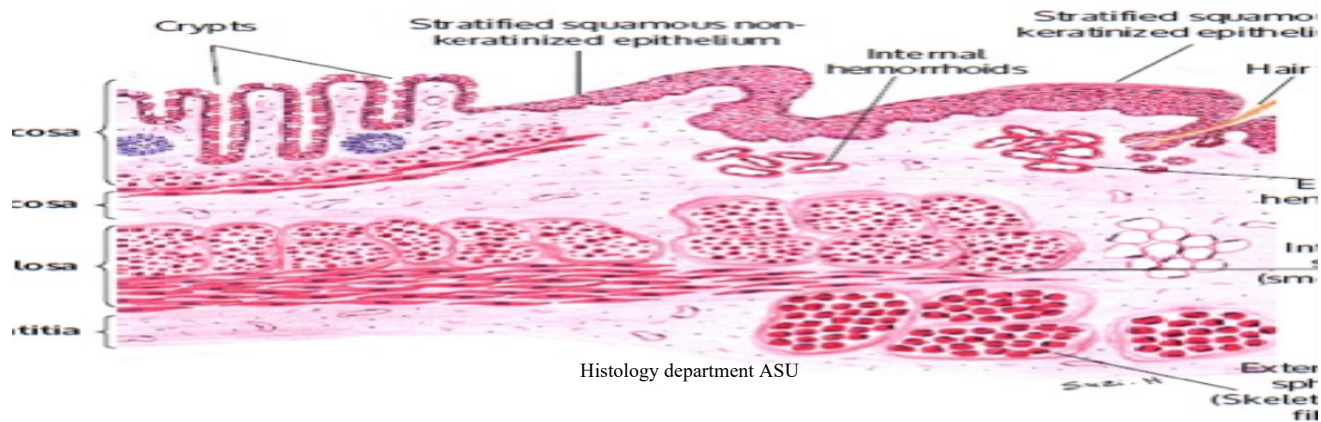
- Its histological structure is similar to the colon **EXCEPT** that:
  - Crypts: fewer in number, containing many goblet cells.
  - NO tenia coli.
  - Adventitia (not serosa).



## Epithelial cell renewal of large intestine

Proliferation of the stem cells arises in the lower half of the crypts. Then they migrate to the surface, where they are lost to the lumen.

## Structure of the rectoanal junction



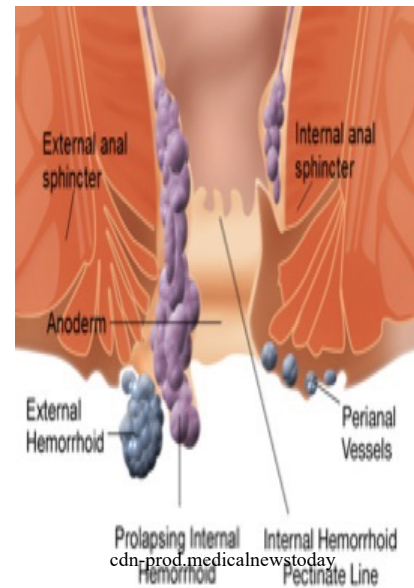
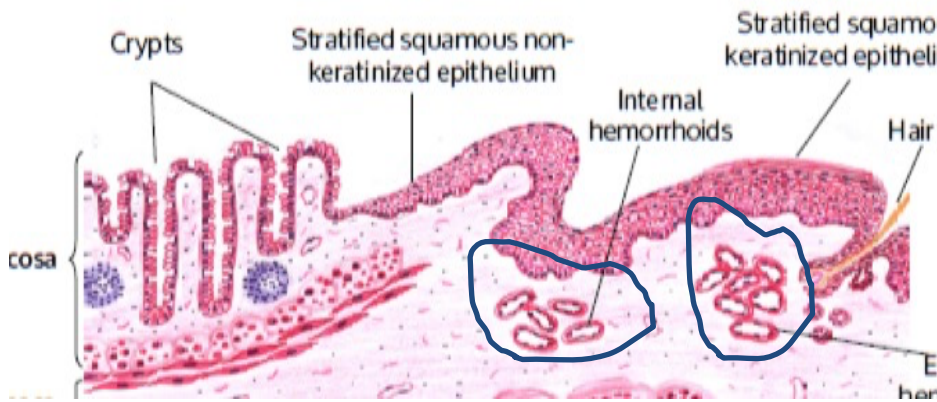
### Microscopically,

1. Crypts become very short, shallow then they disappear.
2. The epithelium: simple columnar in the rectum ➡ stratified squamous non-keratinized ➡ then continuous with the stratified keratinized epithelium of the skin.  
-At the anal orifice the epidermis of the skin shows hair follicles, sebaceous glands and circum-anal glands.
3. The muscularis mucosa continues as far as the rectal columns where it subdivides into bundles then disappears.
4. The submucosa fuses with the lamina propria and shows convoluted veins, which are called **internal hemorrhoidal plexus**. Closer to the anal orifice there are also veins called **external hemorrhoids plexus**.
5. The inner circular muscle fibers thicken to form the **internal sphincter**.
6. The outer longitudinal smooth muscle fibers ➡ extend between the internal and external sphincters ➡ lost in the dermis.



Clinical application:  
**Hemorrhoids**  
**s (Piles)**

- Swollen blood vessels of the **mucosa or submucosal venous plexuses** of anal canal.
- It is manifested by pain and appearance of fresh blood with defecation (evacuation of feces).  
It is either **internal** or **external**





**By the end of this lecture the student will be able to:**

- Describe the basis of the different classifications of hepatic lobules.
- Describe the structure of components of the classic hepatic lobule.
- Correlate the structure of hepatic lobules to their functions
- Describe the light and electron microscopic picture of hepatocytes.
- Interpret the altered microscopic structure of the hepatic lobules & hepatocytes in different diseases.

The liver is the largest gland in the body. it is a compound tubular gland that has both; endocrine (plasma proteins secretion) and exocrine (bile secretion) functions.

### Structure of the liver

#### STROMA

#### PARENCHYMA

#### Capsule of Glisson

Dense CT covered by peritoneum & is thick at the porta hepatis

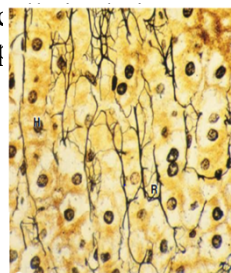
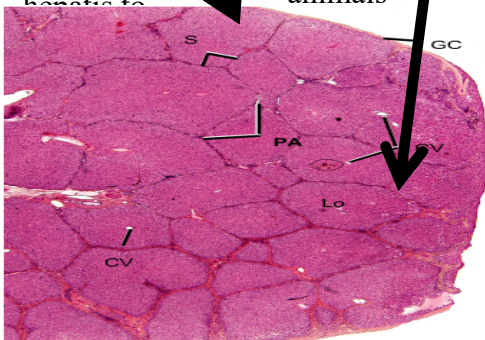
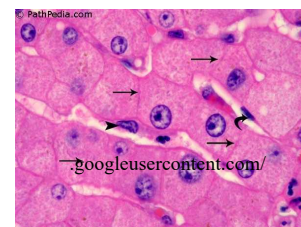
#### Trabeculae (septa)

Divide the gland into Lobules. Thin in human but thick in animals

#### Reticular CT

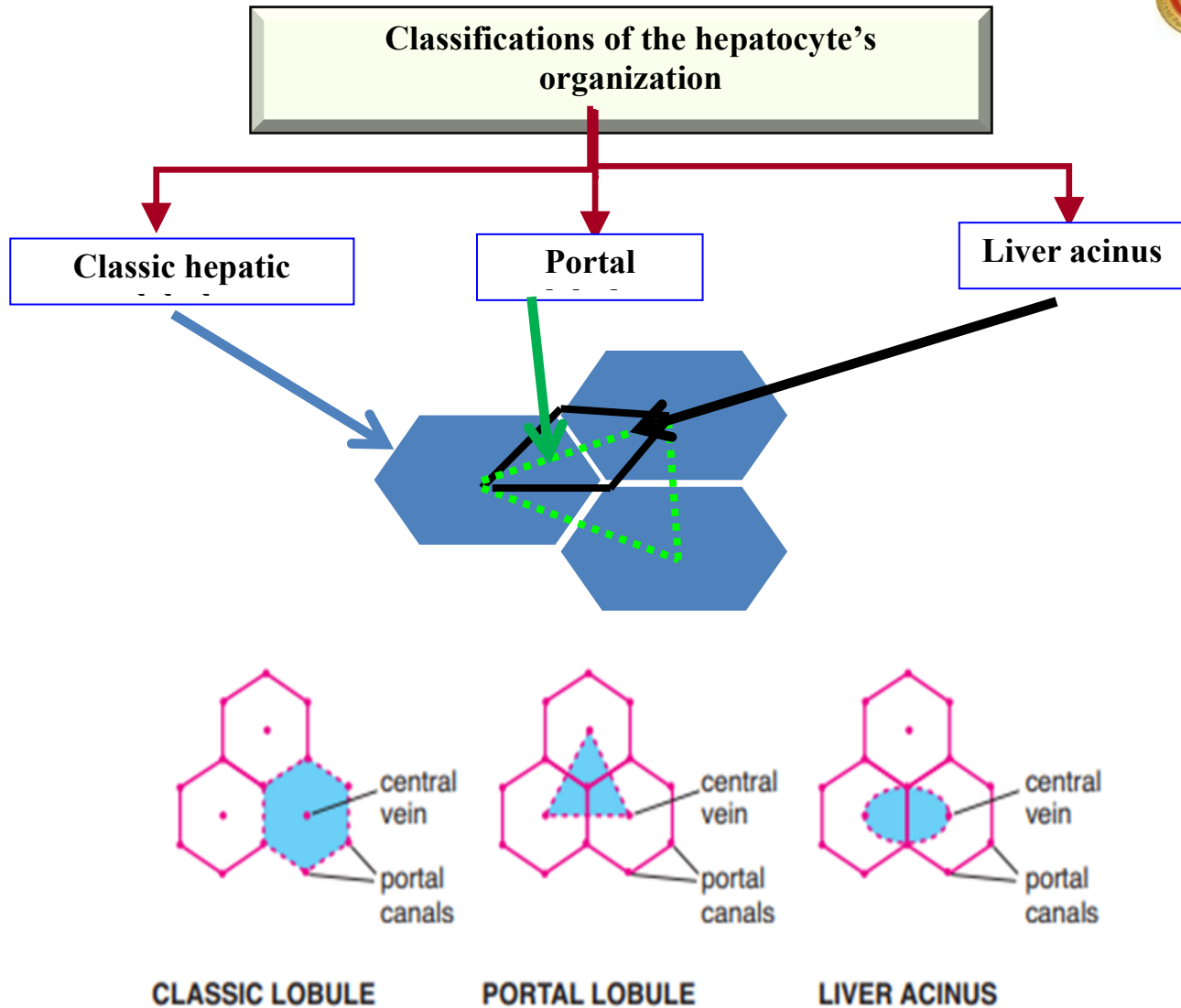
Short branching & anastomosing fibers, forming network that holds the

#### Hepatocytes (liver cells)



Mescher AL: Junqueira's Basic Histology: Text and Atlas, 14<sup>th</sup> Edition.

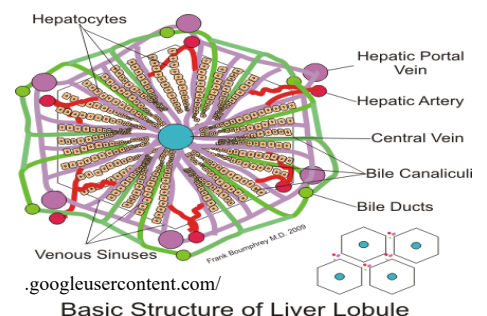




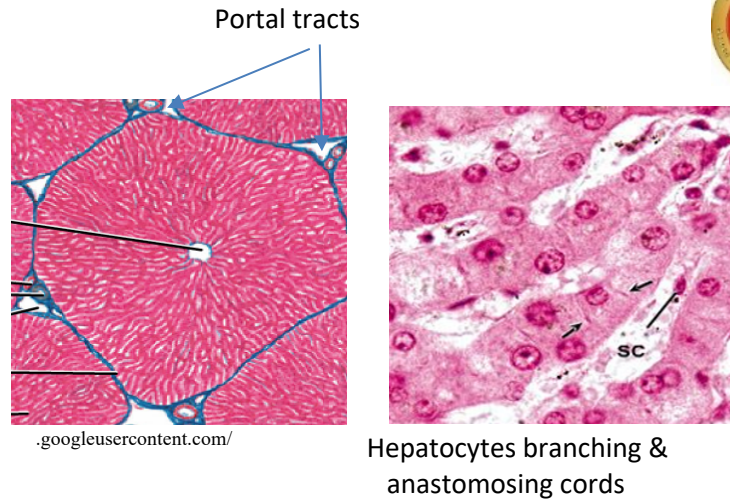
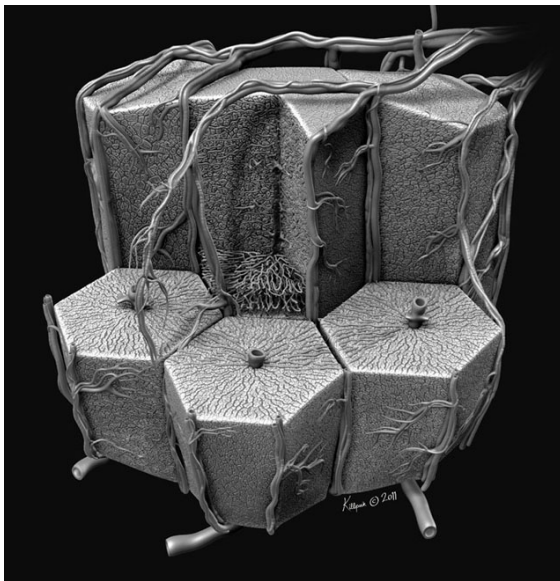
Ross MH, Pawlina W: Histology A Text & Atlas with correlated Cell & Molecular Biology, 6<sup>th</sup> Edition.

### The classic hepatic lobule

- It is hexagonal in shape.
- The central vein is at the center.
- Hepatocytes: branching & anastomosing cords (plates) radiating from the CV to the periphery.
- The cords of hepatocytes: one or 2 cell thick. & separated by blood sinusoids.
- At the corners: portal areas (tracts) are found.



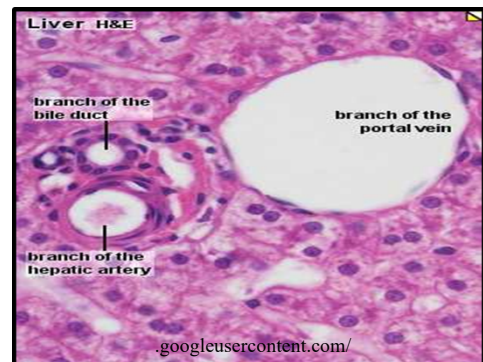




### Portal Tract

- Found at some of the corners of the classic hepatic lobule.
- It contains:

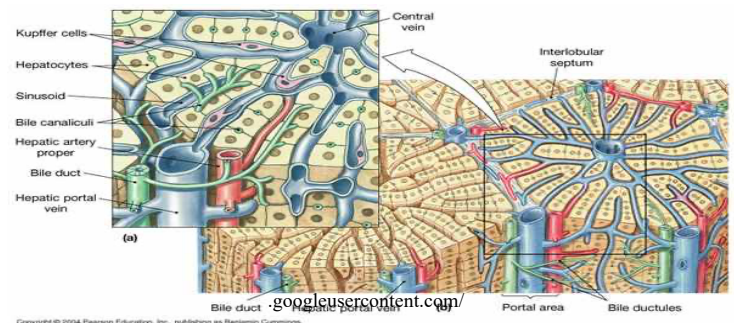
1. Branch of the hepatic artery.
2. Branch of the portal vein (largest).
3. Branch of the bile duct.
4. lymphatic vessels.



- The blood flows from the vessels in portal tract in the periphery to the central vein in the center of the classic hepatic lobule.
- The bile flows from the center to the bile ductules in the portal tracts

### Blood Supply of the Liver

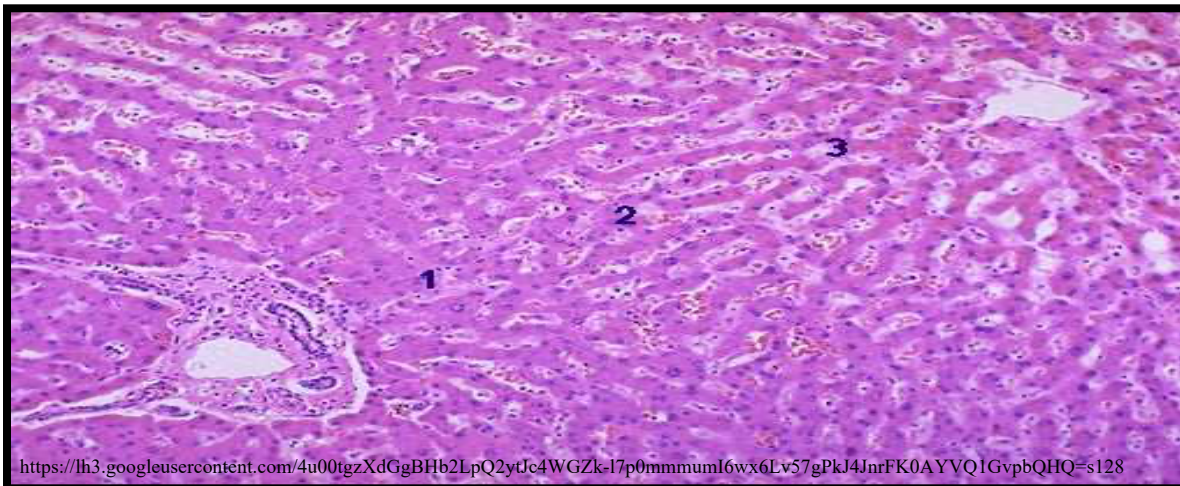
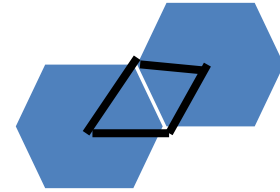
- The liver has two circulatory inputs:
  1. Hepatic artery (75%)
  2. Portal vein (25%)
 Blood from both sources is mixed within the sinusoid





## The liver acinus

- It is a diamond shaped mass of hepatocytes from 2 classic lobules.
- Has a Central vascular core
- **It is divided into 3 zones:**
- **Zone I:** close to central vascular core.
  - Best blood supply.
  - O<sub>2</sub>, nutrients.
  - Synthesize glycogen and plasma proteins.
- **Zone II:** surrounding zone I.
  - Less blood supply than zone I.
  - Intermediate range of metabolic functions between the two zones.
- **Zone III:** close to CV, far from vascular core.
  - Least blood supply.
  - Least O<sub>2</sub>, nutrients.
  - High sER, (drug detoxification)
  - Concerned with glycolysis.
  - First to undergo ischemic necrosis.



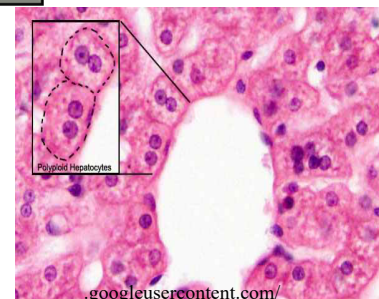
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## Histological Feature of Hepatocytes

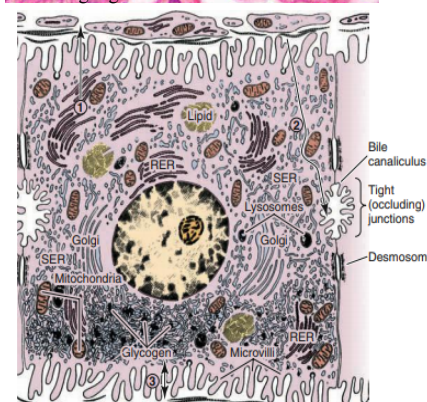
### LM:

- Large polygonal cells.
- Nucleus: central, rounded & vesicular (25% binucleated).
- Cytoplasm: acidophilic (numerous mitochondria) + some basophilic granules (rER & free ribosomes).
- Vacuolations (due to presence of glycogen granules & fat droplets that are not stained with H&E)



### EM:

- Mitochondria: numerous (1000 per cell).
- RER: numerous (for protein synthesis: albumin, globulin and prothrombin).
- Golgi: multiple.
- SER: (for detoxification, glycogenesis, conjugation of bilirubin).
- Lysosomes.
- Peroxisomes: (break fatty acids by  $\beta$ -oxidation).
- Actin, Intermediate filaments.
- Inclusions:
  - glycogen (rosettes)
  - fat droplets.
  - Lipofuscin pigment.



Mescher AL: Junqueira's Basic Histology: Text and Atlas, 14<sup>th</sup> Edition.

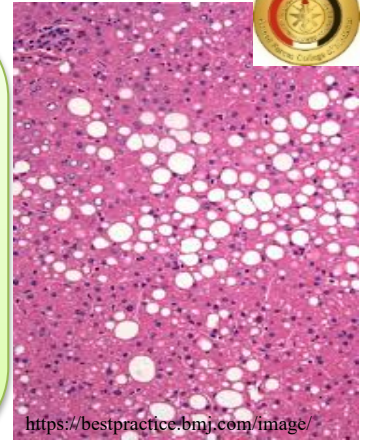
### Functions of hepatocytes:

1. Exocrine function: Secrets bile which help in fat absorption.
2. Endocrine function:
  - Secrete glucose
  - Plasma proteins (albumin, fibrinogen, globulin, and prothrombin) in blood directly. (by rER)
  - Lipoprotein formation (by rER, sER).
3. Detoxication of drugs as barbiturates (by sER) and alcohol (by peroxisomes)
4. Storage & metabolism of iron.
5. Metabolic function:
  - CHO, Lipid, cholesterol.
  - Urea formation.
6. Stores and converts many vitamins (A, D, K)



**Clinical  
application:  
Fatty liver  
disease**

- Reversible condition in which large lipid droplets accumulate abnormally in hepatocytes.
- This disorder has multiple causes, but it occurs most commonly in individuals with **alcoholism** or **obesity**.
- Accumulation of fat in hepatocytes may produce a progressive inflammation of the liver.

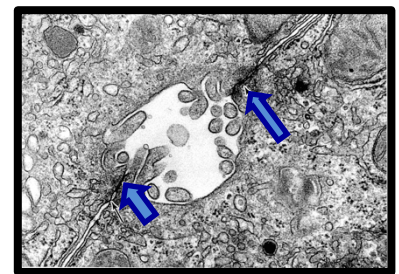


**Surfaces of the hepatocytes:**

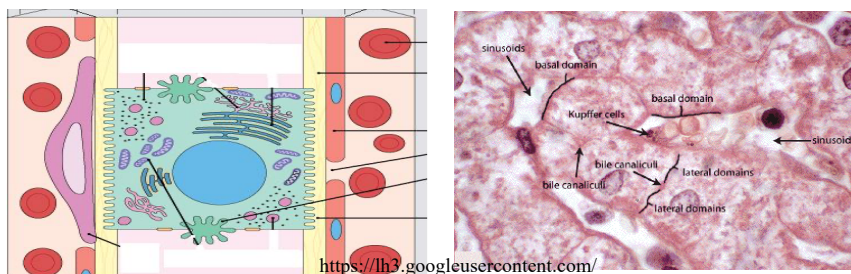
A Hepatocyte has three surfaces that either faces bile canaliculus, blood sinusoids, or another hepatocyte.

**The surface facing bile canaliculus:**

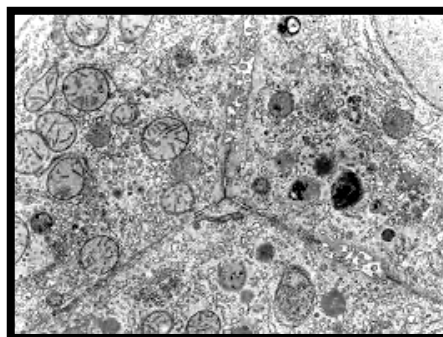
- Contains short microvilli & sealed by tight junctions.
- Bile secreted from hepatocytes in the bile canaliculi is the exocrine function of hepatocytes.



**The surface facing the blood sinusoids:** Contains many long microvilli .



**The surface facing another hepatocyte:** Joined by junctional complexes





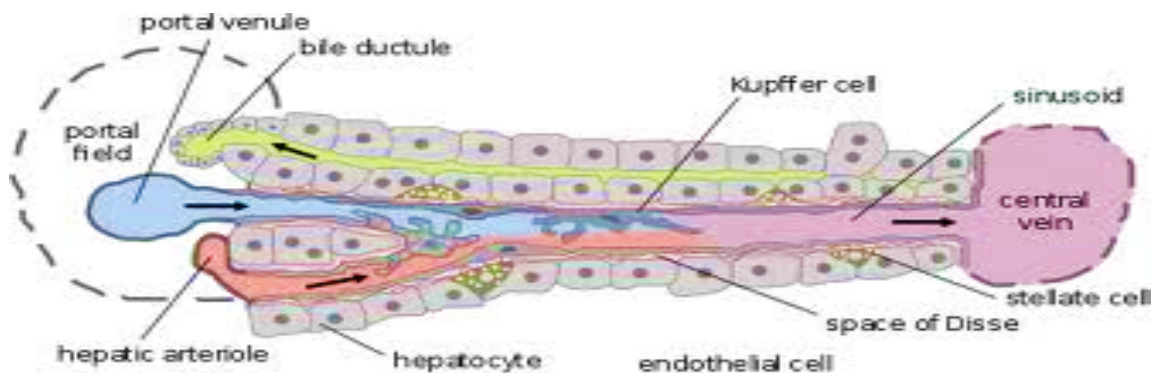


**By the end of this lecture the student will be able to:**

- Describe the cells lining the blood sinusoids.
- Describe the structure of the space of Disse.
- Correlate the structure of space of Disse to its function.
- Correlate the structure to the function of Ito cells (Hepatic stellate cells).
- Describe the structure of intra and extra hepatic biliary passages and gall bladder.
- Describe the structure of gall bladder.

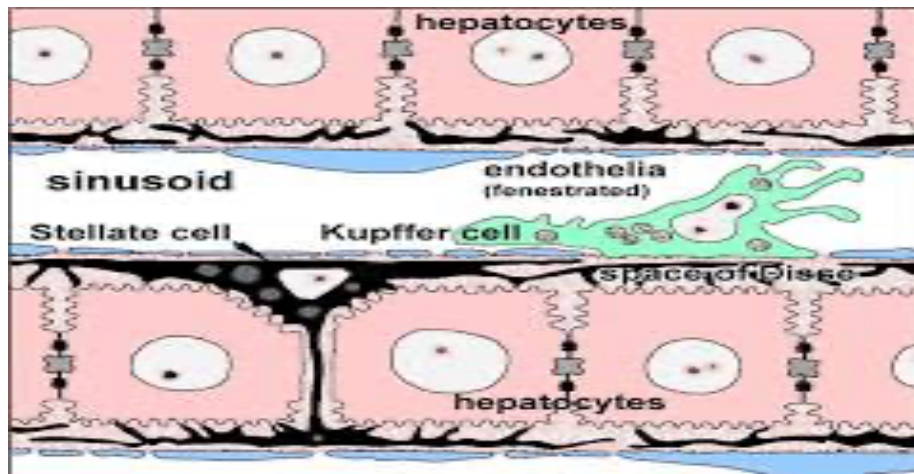
### Structure of the hepatic blood sinusoids

- They are blood channels present between the hepatocytes that conduct blood from the portal area to the central vein.



[https://lh3.googleusercontent.com/JutTuHBaLWL0dnfz4W6f\\_aQTl72Ace1hK-tC0YgNuo8hFFphPMewfCSbJAJ\\_ufndfBpz=s170](https://lh3.googleusercontent.com/JutTuHBaLWL0dnfz4W6f_aQTl72Ace1hK-tC0YgNuo8hFFphPMewfCSbJAJ_ufndfBpz=s170)

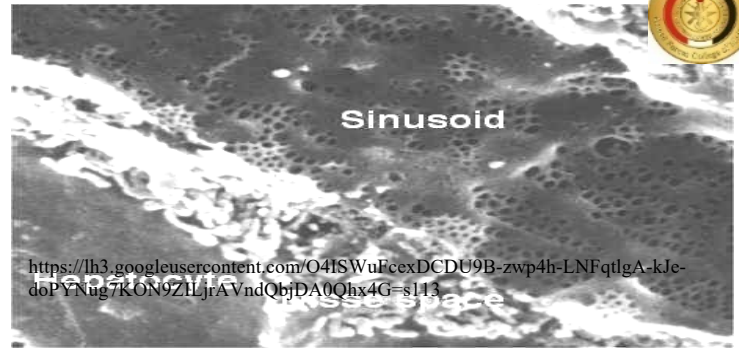
**They are lined by:** Endothelial cells & Von Kupffer cells



[https://lh3.googleusercontent.com/B-rZA3rbPoBEKIOArqRW5sCI4LWb0aOYyGAM7g6OO\\_5aaLQTnhIPn3EzgDfLKRj3YmyPw=s97](https://lh3.googleusercontent.com/B-rZA3rbPoBEKIOArqRW5sCI4LWb0aOYyGAM7g6OO_5aaLQTnhIPn3EzgDfLKRj3YmyPw=s97)

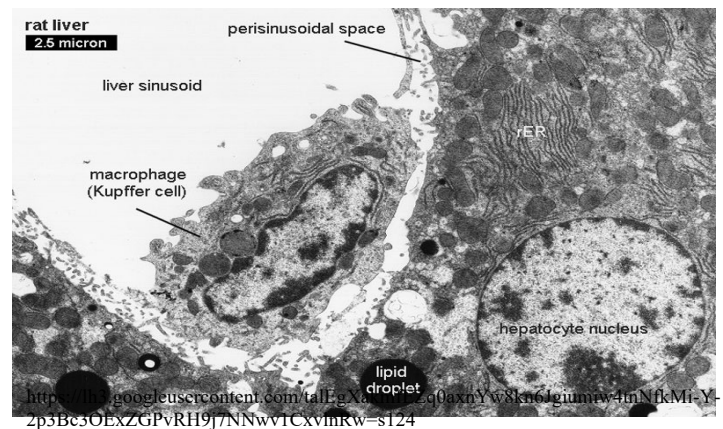
## Endothelial cells

- Fenestrated cells
- Fenestrations and pores lack diaphragm.
- There are spaces between the endothelial cells.
- This allows passage of chylomicrons and plasma from the blood sinusoids to the space of Disse.



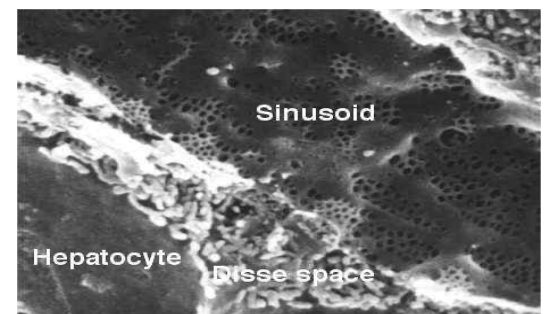
## Von Kupffer cells

- Large phagocytic branching cells between the endothelium.
- **Origin:** monocytes.
- **LM :** nucleus is large and irregular
- **EM:** surface microvilli and pseudopodia, lysosomes, rER, Golgi apparatus, phagocytic vesicles.
- **Functions:**
  1. Phagocytosis of foreign bodies and bacteria.
  2. Phagocytosis of old RBC and free the iron for reuse.
  3. Prevents obstruction of the sinusoids by debris coming from the gut.
  4. Antigen presenting cell.



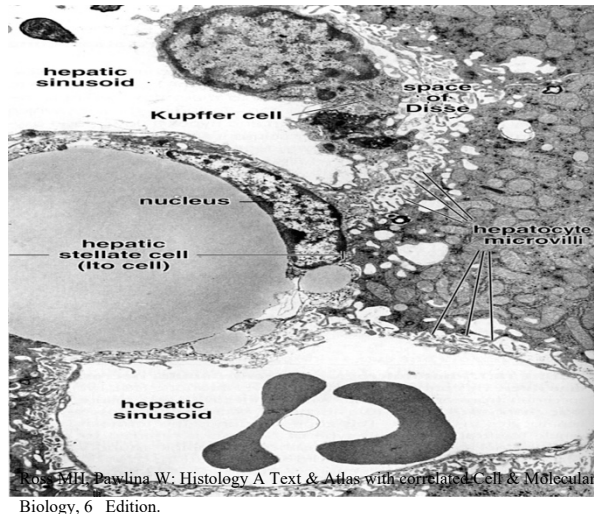
## Space of Disse

- **It is a space Between the hepatocytes and sinusoidal wall & contains:**
  - Microvilli: from the hepatocytes.
  - Plasma.
  - Ito cells : fat storing containing vitamin A –rich lipid inclusions.
  - Reticular fibers (type III collagen).
  - Occasional nerve fibers.
- **Functions:**
  1. Filtered plasma is in direct contact with the hepatocytes so it permits exchange of materials between blood and hepatocytes.
  2. Prevents collapse of sinusoids by:
    - a) Reticular fibers for support
    - b) microvilli of hepatocyte
    - c) Hydrostatic pressure of sinusoids is similar to that space of Disse



***Ito cells (Hepatic stellate cells)***

- Contain lipid droplet.
- Contain vitamin A
- Stores much of the body's vitamin A.
- In diseases: Ito cells proliferate to fibroblast... Leading to fibrosis.



**Clinical application:**  
**Liver fibrosis**

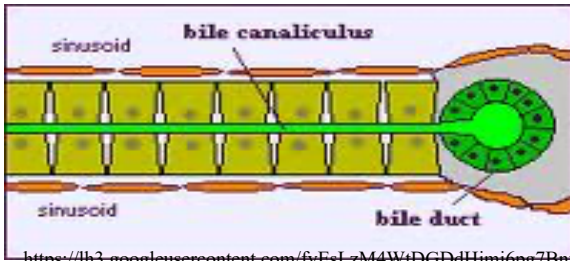
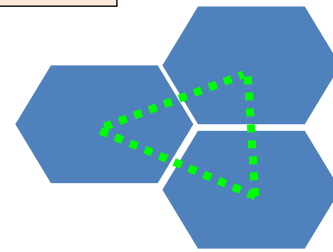
Hepatic stellate cells proliferate into myofibroblasts and produces connective tissue that can fill the perisinusoidal space and interfere with metabolic exchange.



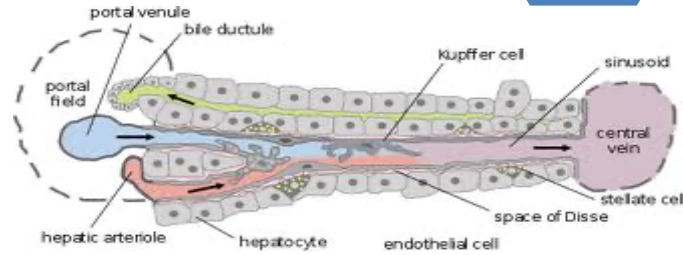
# The portal lobule



- It is a triangular mass of liver from 3 adjacent lobules.
- The bile is drained into the portal tract.



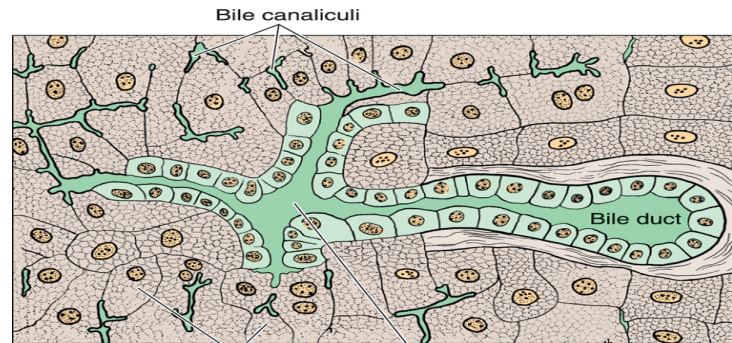
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## Bile flow:

Bile is produced from hepatocytes and released in bile canaliculi and flows to the duodenum through

- Bile canaliculi
- Canal of Herring
- Bile ductules
- Bile ducts in portal tract areas
- Intrahepatic bile duct
- Extrahepatic bile duct Rt & Lt join
- Common hepatic duct
- Common bile duct



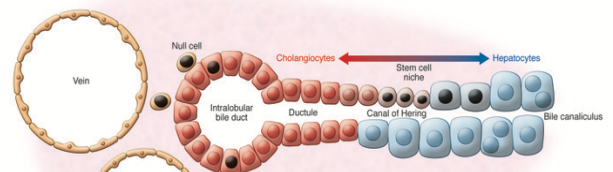
Mescher AL, Junqueira's Basic Histology, Text and Atlas, 14<sup>th</sup> Edition.

- **Bile canaliculi**: lined by hepatocytes and contain microvilli from adjacent hepatocytes.  
***Continuous tight junctions***: seal them from the Inter cellular space.

- **Canal of Herring**: partly lined by hepatocytes and partly by low cuboidal cells (cholangiocytes).

- **Bile ductules** lined by low cuboidal cells.

- **Bile ducts**: lined by cuboidal cells and are found in the portal tract areas. They gradually enlarge and join



[https://lh3.googleusercontent.com/QpiC4y3kqoc9aEiIX6CpAZHE5H3KXq0N1UQSSxsvr34wRj8yaN\\_VjA0iJltUCelth87uGI=s170](https://lh3.googleusercontent.com/QpiC4y3kqoc9aEiIX6CpAZHE5H3KXq0N1UQSSxsvr34wRj8yaN_VjA0iJltUCelth87uGI=s170)

- **Right and left extrahepatic ducts**: lined by simple columnar epithelium.



# The gall bladder



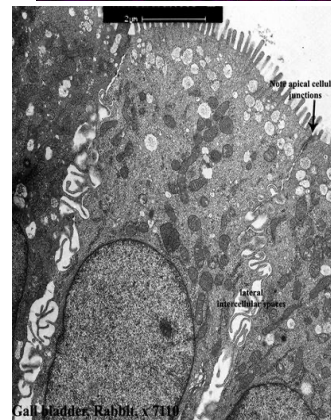
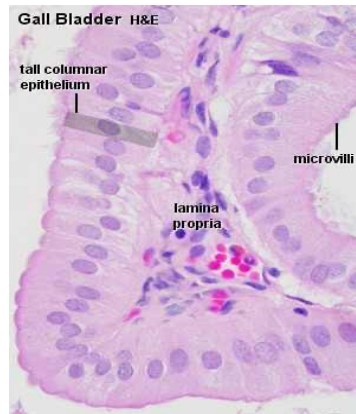
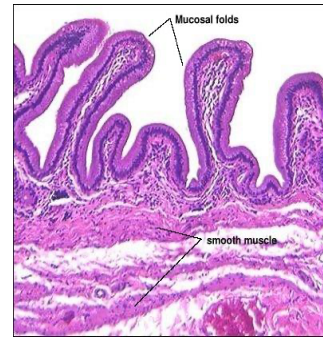
**It is formed of three layers:**

**Mucosa:** Tall simple columnar epithelium that shows:

- Microvilli for absorption
- Many mitochondria
- Intercellular spaces

**Muscle layer.**

**Fibrous coat.**

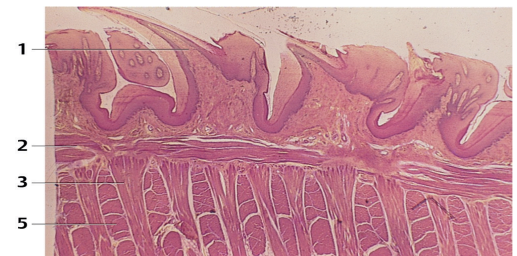


- **Function:**
  - Concentrates the bile (absorptive) and add mucous (secretory)
  - Contraction of its smooth muscle by CCK intermittent discharge the bile in the intestine

## Test your self



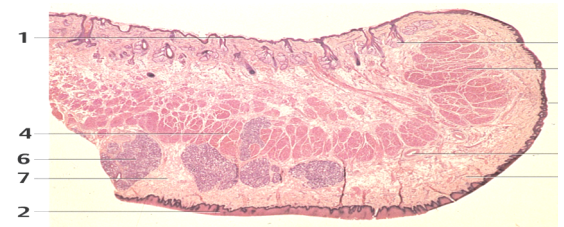
- 1) A 27 years old female went to the plastic surgeon for lip augmentation. The surgeon suggested injection of the lip by hyaluronic acid filler. Which of the following is a unique structural characteristic of the injected part?
  - a) Poor sensory innervation
  - b) Absence of sweat glands
  - c) Numerous hair follicles
  - d) Scanty blood capillaries
  - e) Thick epidermis
- 2) Dermal papillae in the red margin are characterized by which of the following?
  - a) Numerous, deep and of low vascularity
  - b) Few, deep and highly vascular
  - c) Numerous, shallow and highly vascular
  - d) Numerous, deep and highly vascular
  - e) Few, shallow and highly vascular
- 3) Which of the following is a characteristic histological feature for filiform papillae?
  - a) Appear rounded in outline
  - b) Contains numerous taste buds
  - c) Cover the posterior  $\frac{2}{3}$  of the tongue
  - d) Covered with kerat. st. sq. epithelium
  - e) Present on the sides and tip of tongue
- 4) Which of the following characterizes the circumvallate papillae?
  - a) They contain few taste buds
  - b) They are surrounded by a deep groove
  - c) They are numerous in the tip of tongue
  - d) They contain many nerve afferents for touch
  - e) Covered by a relatively transparent epithelium
- 5) A 65-year-old woman presents with a five-month history of a painful ulcer on the tongue. It did not improve with topical therapy, and an incisional biopsy was performed. A histopathological slide obtained from the specimen is being examined. Which of the following is true for structure 1 in the figure?
  - a) It is devoid of taste buds
  - b) It is rarely found in the human tongue
  - c) It is associated with a thick smooth muscle layer
  - d) It is distributed predominantly parallel and anterior to the sulcus terminalis
  - e) It is distributed predominantly parallel and posterior to the sulcus terminalis
- 6) The upper surface of the soft palate is covered with which type of the following epithelium?
  - a) Stratified columnar epithelium
  - b) Stratified squamous keratinized epithelium
  - c) Stratified squamous non keratinized epithelium
  - d) Pseudostratified epithelium with goblet cells
  - e) Simple columnar epithelium with goblet cells



- 7) A 39-year-old woman come to a physician because of mild clumsiness when walking, tingling of her hands and feet and persistent fatigue. She states that she has maintained the same balanced diet. Her temperature is 36.9°C (98.4 °F), pulse is 80/min., respirations are 14/min., and blood pressure is 128/76 mmHg. Physical examination shows a smooth red tongue with loss of the parallel rows of papilla. Which of the following is the character of this papilla?
- They are bright red in color
  - Rich in taste bud
  - Associated with Von Ebner gland
  - Mushroom like
  - Heavily keratinized
- 8) In which of the following structures of the oral cavity would taste buds be localized in the least concentration?
- Gingiva
  - Vallate papillae
  - Filiform papillae
  - Fungiform papillae
  - Ventral surface of the tongue
- 9) A 48-year-old man complains of painful ulcers in his mouth. Physical examination reveals multiple shallow ulcers on the inner surface of the upper lip and cheek. The patient is subsequently diagnosed with aphthous stomatitis, an inflammation of the oral mucosa.
- Which of the following types of epithelium would be affected?**
- Simple squamous
  - Simple columnar
  - Stratified columnar
  - Keratinized stratified squamous
  - Nonkeratinized stratified squamous
- 10) A 13-year-old child reports to the clinic with a small swelling on the right part of the lower lip for the past two months. The swelling was diagnosed as a mucocele and was surgically resected along with a surrounding rim of normal lip tissue (see the image).

**Which of the following is true for structure 1?**

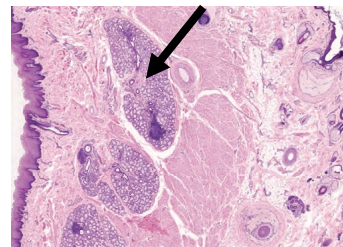
- Associated with smooth muscles
- Associated with sebaceous glands
- Characterized by absence of keratin
- Lined by simple columnar epithelial cells
- Associated with sensory nerve endings of the facial nerve



- 11) Which is the type of epithelium associated with the transitional area between the thin skin of the lip and its mucous membrane?
- Stratified cuboidal
  - Stratified columnar
  - Stratified squamous keratinized
  - Pseudostratified ciliated columnar
  - Stratified squamous nonkeratinized

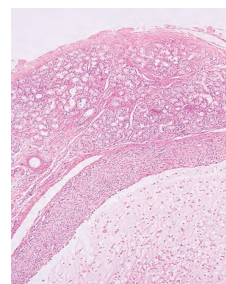
**12) A lip biopsy is sectioned and prepared with routine H&E staining (shown in the image). Identify the structures indicated by the arrows.**

- a) Fordyce spots
- b) Minor salivary gland
- c) Sebaceous gland
- d) Sublingual gland
- e) Submandibular gland



**13) A 22-year-old woman presents with a bluish, translucent cyst on her lower lip. Laboratory examination of a biopsy demonstrates a cystic cavity filled with mucus and surrounded by a layer of granulation tissue (shown in the image). Trauma to which of the following oral structures most likely resulted in the formation of this patient's mucus-filled cystic lesion?**

- a) Blood vessels in the lamina propria
- b) Large blood vessels in submucosa
- c) Lymphatic vessels
- d) Minor salivary glands
- e) Sublingual gland



**14) A 57-year-old woman with no past medical history comes to the physician for a routine medical examination. She has smoked two packs of cigarettes daily for the past 20 years. Physical examination shows a 1-cm flat white patch of buccal mucosa. The lesion could not be scrapped off with a tongue depressor. The physician recommends a biopsy of the lesion. What is the normal lining epithelium of this area?**

- a) Stratified squamous keratinized
- b) Stratified squamous non-keratinized
- c) Stratified columnar
- d) Stratified cuboidal
- e) Transitional

**15) A histologist was assigned to examine a box filled of unlabeled stained slides of the GIT. Which of the following uniquely characterizes a slide containing the lingual muscle?**

- a) Being formed of smooth fibers
- b) Branching and anastomosing fibers
- c) Covered by simple columnar epithelium
- d) Present in the anterior part of the tongue
- e) Running in three perpendicular directions

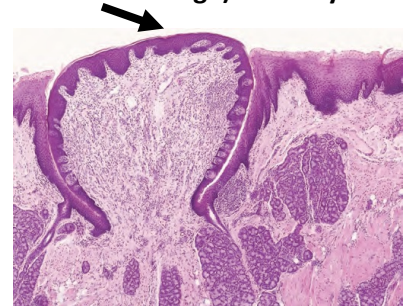
**16) In which of the following structures of the oral cavity would taste buds be localized in the highest concentration?**

- a) Gingiva
- b) Vallate papillae
- c) Filiform papillae
- d) Fungiform papillae
- e) Ventral surface of the tongue



**17) The epithelium overlying the dorsal surface of the tongue is examined (shown in the image). Identify the structure indicated by the arrow.**

- a) Circumvallate papilla
- b) Filiform papilla
- c) Foliate papilla
- d) Fungiform papilla
- e) Lymphatic nodule



**18) Which one of the following statements about taste buds is true?**

- a) Taste buds are abundant in fungiform papillae
- b) The epithelial cells in taste buds have microvilli
- c) Taste buds are not associated with nerve endings
- d) Taste buds are scattered over lower surface of the tongue
- e) Filiform papillae contain taste buds that are sensitive to salt

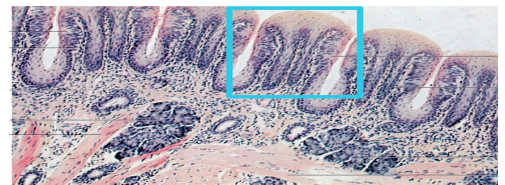
**19) Which of the following contain MOST numerous taste buds on the sides?**

- a) Circumvallate papilla
- b) Filiform papilla
- c) Foliate papilla
- d) Fungiform papilla
- e) Lymphatic nodule

**20) A 24-year-old woman presents to the outpatient department with complaints of foreign body sensation of the throat for the last 1 year. A physical examination and CT scan of the neck revealed a pleomorphic adenoma affecting the base of the tongue, and a midline glossotomy was performed. The image is obtained from her biopsy specimen.**

**Which of the following is true for the structure contained within the blue rectangle in the figure?**

- a) It is devoid of taste buds
- b) It is heavily keratinized
- c) It lies parallel and anterior to sulcus terminalis
- d) It is not frequently found in the adult human
- e) The connective tissue underneath the lamina propria is devoid of lingual glands



**21) While examining a 60-year-old man in a regular checkup, the doctor suspected a lesion in the back of the roof of the mouth, and suggested to take a biopsy. What type of epithelium is expected to be seen on the upper surface of this part?**

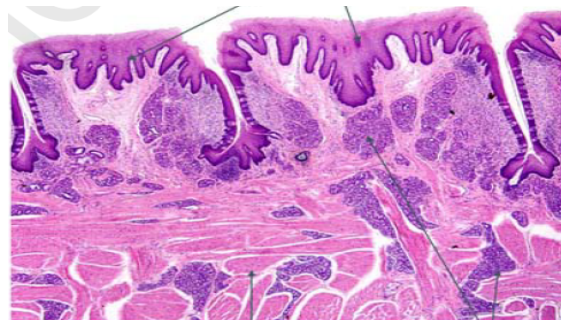
- a) Stratified squamous keratinized epithelium.
- b) Stratified squamous non keratinized epithelium.
- c) Pseudostratified epithelium with goblet cells.
- d) Stratified columnar epithelium.
- e) Simple columnar epithelium with goblet cells.

**22) A 20-year-old male patient was brought into emergency after a traffic accident. He got multiple fractures for which he was immediately operated. After fifteen days of heavy antibiotics and low immunity, he develops thrush in the mouth. There was coating of the oral mucosa and the tongue with a whitish layer and was unable to feel the taste of food. Which of the following microscopic characteristics is normally present in the affected structure?**

- a) Apical cilia
- b) Basal cytoplasmic striations.
- c) Cytoplasmic mucous granules
- d) Elongated cells with microvilli
- e) Acidophilic zymogen granules

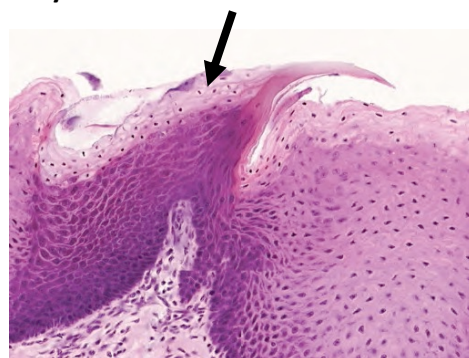
23) A 13-year-old child reports to the clinic with a small swelling on the right part of the lower lip for the past two months. The swelling was diagnosed as a mucocele and was surgically resected along with a surrounding rim of normal lip tissue (image). Which of the following is true for structure pointed to by the arrow?

- a) Lined by simple columnar epithelial cells
- b) Characterized by absence of keratin
- c) Associated with sebaceous glands
- d) Associated with smooth muscles
- e) Associated with sensory nerve endings of the facial nerve



24) The dorsal surface of a tongue specimen is examined at high magnification (shown in the image). Which of the following describes the most likely function of the structure indicated by the arrow?

- a) Pain receptor
- b) Response to bitter taste.
- c) Response to umami taste
- d) Surface for food movement
- e) Temperature receptor



25) On examining a biopsy of tongue, which of the following is a characteristic histological feature for the type of papillae that facilitate chewing of food?

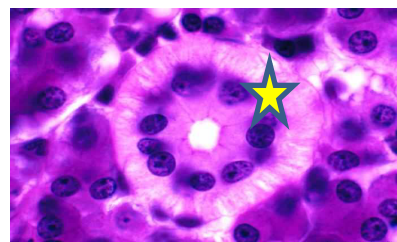
- a) Appear rounded in outline
- b) Contains numerous taste buds
- c) Cover the posterior 2/3 of the tongue
- d) Present on the sides and tip of the tongue
- e) Covered with keratinized squamous epithelium

26) The parotid gland is characterized by which of the following?

- a) Few fat cells in the septa.
- b) Mixed muco-serous acini.
- c) Well-developed striated ducts.
- d) Thin connective tissue capsule.
- e) Ill-defined septa with few lymphocytes.

27) Which of the following best describes the cells marked by the star in the opposite figure?

- a) Are squamous cells
- b) Apical mitochondria
- c) Cells act as stem cells
- d) The cytoplasm is basophilic, granular with basal striation
- e) Have basal infoldings of cell membrane (contains Na-K ATPase)



**28) Which of the following is true about the parotid glands?**

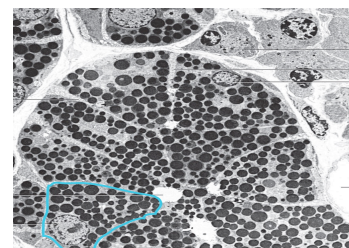
- a) Are purely mucous.
- b) Show prominent striated ducts.
- c) Have thin capsules.
- d) Secrete 75% of saliva
- e) Are single organs

**29) Which of the following is true about the Submandibular glands?**

- a) Are purely serous
- b) Are purely mucous
- c) Are mostly serous
- d) Are mostly mucous
- e) Mostly mixed

**30) During facial reconstruction surgery following a trauma in a 68-year-old man, normal glandular tissue from several of his major salivary glands was removed. A histological slide obtained from one such tissue specimen is seen in the figure.**

**Which of the following is true for the cell outlined in blue?**



- a) It produces a thick, cloudy secretion
- b) It is the primary cell found in the parotid gland
- c) It is the primary cell found in the sublingual gland
- d) It is the only cell found in the submandibular gland
- e) The basal portion of the cell stains strongly acidophilic

**31) Which of the following statements can be applied to the striated ducts of salivary glands?**

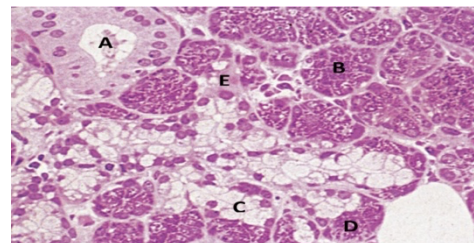
- a) Are inter lobular in position
- b) They are involved in  $Ca^{2+}$  transport
- c) Bear microvilli on their free surface
- d) Show basal infoldings of plasma membrane
- e) Have smaller diameter than intercalated ducts

**32) The Submandibular gland is characterized by which of the following?**

- a) Absence of striated ducts.
- b) Predominant serous acini.
- c) Predominant mucous acini.
- d) Numerous fat cells in the septa.
- e) Thin connective tissue capsule.

**33) In the opposite figure, which labeled structure secretes mucous?**

- a) A
- b) B
- c) C
- d) D
- e) E



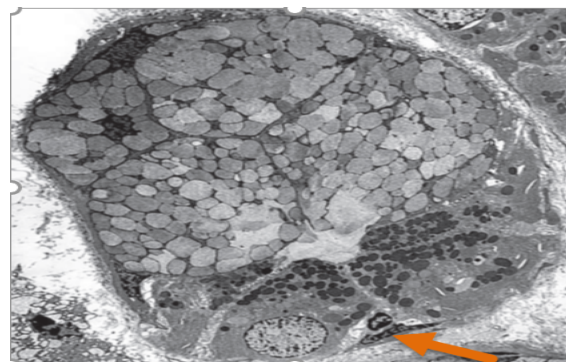
34) A 6-year-old girl presents to the physician with a bilateral swelling in front of her ears extending below the ear lobules towards the neck. She was diagnosed of having mumps.

On microscopy the affected gland normally has which of the following features?

- a) Lobes are indistinct
- b) Purley serous in nature
- c) Purely mucous in nature
- d) Simple tubular type of gland
- e) The acini have cuboidal shaped cells

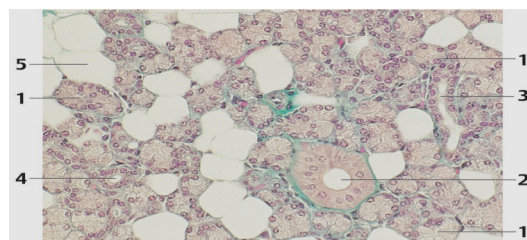
35) A 69-year-old man presented with a tumor of the right submandibular gland. A histological slide prepared from the biopsy specimen has been attached. Which of the following is true for the structure indicated by arrow in the figure?

- a) It secretes watery fluid rich in enzymes
- b) It secretes viscid fluid rich in mucus
- c) Contraction helps to expel secretory product
- d) It is the primary cell type in any salivary gland
- e) It possesses desmin as intermediate filaments



36) A 44-year-old woman presents with a 6-month history of a painless swelling in the region of the right parotid gland. Fine needle aspiration shows presence of hyperplastic glandular cells. Surgical excision of the mass included a portion of the normal parotid gland. Paraffin section is being examined under the microscope (image). Which of the following is correct for the structure labeled 2 in the figure?

- a) It shows striations
- b) Secretes mucous
- c) Acts as stem cell niche
- d) It has no major role in modifying the composition of saliva
- e) It is lined by stratified columnar cells



37) A 47-year-old man presents with a painless, moveable firm mass near the angle of his left mandible. Needle biopsy reveals a pleomorphic adenoma of the parotid gland, and the tumor is surgically excised. Normal glandular tissue at the margin of the surgical specimen is examined in the pathology department. Which of the following is expected to be seen?

- a) Mucous acini
- b) Mucoserous acini
- c) Serous acini
- d) Centroacinar cells
- e) Mucous acini with serous demilunes

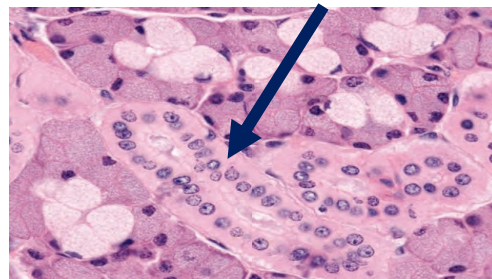


**38) An investigator is isolating mucin secreting cells from various tissues to compare surface receptors types on these cells. Which of the following tissues would most likely yield the highest percentage of mucin secreting cells?**

- a) Esophageal mucosa
- b) Oral mucosa
- c) Parotid gland
- d) Sublingual gland
- e) Submandibular gland.

**39) A region of the submandibular gland is examined at high magnification (shown in the image). Identify the structure indicated by the arrow.**

- a) Excretory duct
- b) Intercalated duct
- c) Mucous tubuloacinus
- d) Serous acinus
- e) Striated duct



**40) Laboratory studies demonstrate the presence of immunoglobulin A (IgA) in saliva obtained from healthy individuals. This antibody is synthesized and secreted by which of the following cells?**

- a) Fibroblasts in surrounding connective tissue
- b) Mucous cells in acini
- c) Myoepithelial cells in acini
- d) Plasma cells in surrounding connective tissue
- e) Serous cells in acini

**41) Submandibular duct cells secrete which of the following substances?**

- a) Glucagon
- b) Lysozyme
- c) Insulin
- d) Plasma proteins
- e) Proteases

**42) Which of the following statements is *true* about the striated ducts of salivary glands?**

- a) are involved in  $\text{Ca}^{+}$  transport
- b) show basal infoldings of plasma membrane
- c) bear microvilli on their free surface
- d) are inter lobular in position
- e) have smaller diameter than intercalated ducts

**43) Which of the following is true about the muscularis externa of GIT?**

- a) Has 2 layers of skeletal muscle fibers.
- b) Contains Meissner's plexus of nerves.
- c) Responsible for peristalsis of the tube.
- d) Consists mainly of longitudinal muscle fibers.
- e) Helps in secretion of mucosal glands of the GIT.

**44) Which of the following applies to Meissner's plexus of nerves?**

- a) Absent in the small intestine
- b) Contains only sympathetic nerve plexus.
- c) Regulates peristaltic contractions of the GIT.
- d) Controls secretory activity of submucosal glands.
- e) Located between the muscle layers of muscularis externa.

**45) Which of the following characteristics of GI intrinsic innervation corresponds to Auerbach's plexus?**

- a) Location: Submucosa
- b) Function: Gut secretion
- c) Function: peristalsis
- d) Function: mucosal movement
- e) Parasympathetic effect: increase secretion.

**46) The gastrointestinal (GI) tract is compartmentalized into organs that are specialized for digestion of food and absorption of nutrients. Most variation and specialization along the length of the GI tract occur in which of the following tissue layers?**

- a) Epithelium of mucosa
- b) Lamina propria
- c) Muscularis externa
- d) Muscularis mucosae
- e) Submucosa

**47) Which of the following characterizes the mucosa of the esophagus?**

- a) Unidentifiable muscularis mucosa
- b) Contains Meissner's plexus of nerves
- c) Lined by stratified cuboidal epithelium
- d) Contains serous acini in the lower part
- e) Mucous glands in its upper and lower parts

**48) Which of the following is characteristic to the lower part of esophagus?**

- a) It has many tubular mucosal glands
- b) It has mucous gland in the serosa
- c) It has skeletal muscle in muscularis mucosa
- d) It has skeletal muscle in muscularis externa
- e) Its lining epithelium contains many goblet cells

**49) A 45-year-old man complains of difficulty swallowing and a tendency to regurgitate his food. Further studies demonstrate a complete absence of peristalsis and failure of the lower esophageal sphincter to relax upon swallowing. These clinicopathologic findings are explained as a deficiency of which of the following structures in the distal esophagus?**

- a) Presynaptic sympathetic nerves
- b) Presynaptic parasympathetic nerves
- c) Ganglion cells in the Meissner plexus
- d) Ganglion cells in the Auerbach plexus
- e) Smooth muscle in the muscularis externa

- 50) A 50 years old man presented to the clinic with an epigastric pain after meals. The history revealed taking proton pump inhibitor drugs for several days to treat his chronic heartburn. The endoscopic examination revealed the presence of salmon pink areas. How would the esophageal epithelium attribute to this color?**
- a) Normal simple cubical epithelium
  - b) Change of st. sq to simple columnar
  - c) Normal stratified squamous epithelium
  - d) Change of st. columnar to simple columnar
  - e) Change to pseudostratified columnar epithelium
- 51) Passage of a bolus through the esophagus into the stomach is facilitated by which of the following?**
- a) Reflux through the gastroesophageal sphincter
  - b) Contraction of the esophageal muscularis externa
  - c) Skeletal muscles of the gastric muscularis mucosa
  - d) Reflux through the pharyngoesophageal sphincter
  - e) Smooth muscle in the esophageal muscularis mucosa sphincter
- 52) A 40 years old female presented to the clinic with dysphagia. The investigation revealed the presence of an upper esophageal tumor. On histological examination of the esophageal biopsy from this part, what is the characteristic feature of the muscularis externa?**
- a) It contains mixed types of muscles
  - b) It is formed of oblique muscle fibers
  - c) It is formed of smooth muscle fibers
  - d) It is formed of skeletal muscle fibers
  - e) It contains Meissner's plexus of nerves
- 53) A 36-year-old man presents with dysphagia of acute onset. A biopsy obtained from a suspicious area during routine endoscopy was found to be normal histologically. Presence of submucosal glands, skeletal muscles, and a prominent muscularis mucosal layer was noted in the section. Which of the following additional features might be normally found in the specimen?**
- a) Teniae coli
  - b) Prominent villi
  - c) Abundant goblet cells
  - d) Mucosa lined by simple columnar epithelium
  - e) Mucosa lined by stratified squamous epithelium
- 54) On performing endoscopy for a 55-year-old heavy smoker man with heart burn symptoms for more than 2 years, Salmon pink patches were viewed in the esophageal mucosa. This can be attributed to which of the following?**
- a) Absence of mucous secreting glands of lamina propria
  - b) Destruction of neurons of Meissner's plexus of submucosa
  - c) Destruction of neurons of Auerbach's plexus of musculosa
  - d) Change of stratified squamous into intestinal epithelium
  - e) Metaplasia of simple columnar into stratified squamous epithelium

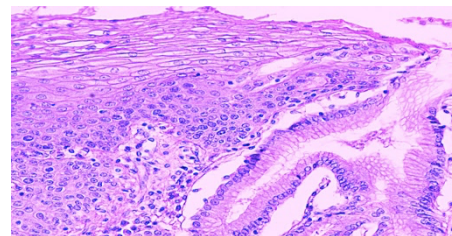
- 55) A 51-year-old male long-term smoker presents with heartburn after eating, especially if he is lying down. The pain is lessened if he takes antacids. Which of the following are normal histologic findings of the esophagus?**
- a) Goblet cells secreting acid mucin in the mucosa
  - b) Mucus-secreting cardiac glands in the lamina propria
  - c) Keratinized squamous epithelium
  - d) Skeletal muscle in the muscularis externa of the lower third of the esophagus
  - e) Smooth muscle in the muscularis externa of the upper third of the esophagus
- 56) A 50-year-old man complains of chronic heart burn. The endoscopy revealed irregular esophageal red areas, the stomach mucosa was free of lesions. This condition can be attributed to which of the following?**
- a) Loss of the simple squamous epithelium.
  - b) Irregular esophageal longitudinal folds.
  - c) Increased submucosal mucous glands.
  - d) Metaplasia of stratified to simple epithelium.
  - e) Increase in esophageal sphincter tone
- 57) A 27-year old man comes to the physician because of heartburn and a sour taste in throat that occurs after meals. These symptoms have not been alleviated by over-the-counter medications. Endoscopy has been performed and the biopsy of the distal esophagus shows no abnormalities. Histologic examination of the biopsy is most likely to show which of the following cell types in the mucosal lining?**
- a) Ciliated columnar epithelium
  - b) Keratinized stratified squamous epithelium
  - c) Non ciliated columnar epithelium
  - d) Non keratinized simple squamous epithelium
  - e) Non keratinized stratified squamous epithelium
- 58) During a small group discussion, you are asked to explain structural and functional differences between rugae, villi, microvilli, plicae circulares, teniae coli, and haustra. Rugae are found in which of the following segments of the GI tract?**
- a) Esophagus
  - b) Large intestine
  - c) Rectum/anal canal
  - d) Small intestine
  - e) Stomach
- 59) Which of the following statements concerning stomach is true?**
- a) Chief cells are present at the upper part of gastric pits
  - b) Parietal cells secrete carbonic acid
  - c) Pylorus has no gastric pits
  - d) Chief cells secrete pepsin
  - e) The adventitia is coated with mesothelium



- 60) Which one of the following statements is true about parietal cell?**
- a) They have invaginated apical surface
  - b) They are stained deep basophilic
  - c) They have few mitochondria
  - d) They secrete gastric extrinsic factor
  - e) They secrete cholecystokinin
- 61) A 39-year-old woman presents with dyspnea, fatigue, pallor, tachycardia, anosmia, and diarrhea. Laboratory results are: hematocrit 32% (normal 36.1%-44.3%), MCV 102 fL (normal 78-98 fL), 0.3% reticulocytes (normal 0.5%-2.0%), 95 pg/mL vitamin B12 (normal 200-900 pg/mL), and an abnormal stage I of the Schilling test. Autoantibodies are detected against a cell type located in one region of the GI tract. In which regions would those cells be found?**
- a) Esophagus
  - b) Body of the stomach
  - c) Pyloric region of the stomach
  - d) Cardiac region of the stomach
- 62) A 65-year-old man presented to the clinic by constant diarrhea not responding to drug treatment for 2 months. The doctor requested to perform an endoscopic examination and biopsy of the stomach. Which of the following would be normally present in the stomach microstructure?**
- a) Plicae circularis
  - b) Few gastric foveolae
  - c) Two-layered muscularis externa
  - d) Compound tubular mucosal glands
  - e) Rugae formed of mucosa and submucosa
- 63) A patient presented to the clinic with heartburn which is not relieved by over-the-counter antacids. The doctor prescribed him a proton pump inhibitor for 6 months. This drug is expected to inhibit secretion of which of the following cells?**
- a) Chief cells
  - b) Stem cells
  - c) Parietal cells
  - d) Mucous neck cells
  - e) Enteroendocrine cells
- 64) Which is the characteristic finding of active parietal cells upon examination by the TEM?**
- a) Numerous sER
  - b) Numerous rER
  - c) Little Golgi complex
  - d) Numerous tubulovesicles
  - e) Deep intracellular canaliculi
- 65) Granules of the enteroendocrine cells are characterized by which of the following?**
- a) They are PAS positive
  - b) Basophilic and apical
  - c) They stain negatively with silver
  - d) They are situated basally in the cells
  - e) They are distributed all over the cell

**66) A histologist views the accompanying tissue in a biopsy. He determined that the tissues were normal. The presence of both of these tissues indicate that the sample was taken from the junction between which of the following?**

- a) Cheeks and lip.
- b) Ileum and colon.
- c) Anal canal and rectum.
- d) Esophagus and stomach.
- e) Stomach and duodenum.



**67) A 45-year-old male patient is brought into the emergency room with bleeding per mouth. On endoscopy there is an actively bleeding area about 10-15 mm seen in the gastric mucosa. The biopsy was taken, and the patient managed accordingly as the case of gastric ulcer.**

**Which of the following is true about the cells mostly affected and decreased in function in this condition?**

- a) Have deep elongated intracellular canaliculi.
- b) Have many microvilli covering their basal surfaces
- c) Contain basal secretory granules and actin filaments.
- d) Have basophilic cytoplasm with apical acidophilic granules.
- e) Have pale basophilic vacuolated cytoplasm with basal nuclei.

**68) A 58-year-old woman with a history of indigestion after meals and “heartburn” presents with upper abdominal pain. She is currently being treated with proton pump inhibitors for gastroesophageal reflux disease (GERD). Which of the following types of epithelial cells has proton pumps and generates hydrochloric acid (HCl) within the lumen of the stomach?**

- a) Chief cells
- b) Enterocytes
- c) Goblet cells
- d) Paneth cells
- e) Parietal cells

**69) You are investigating the activation of smooth muscle in the muscularis mucosae of the stomach and its role in assisting outflow from gastric glands.**

**The cell bodies for visceral motor fibers that innervate the muscularis mucosae are present in which of the following anatomic locations?**

- a) Celiac ganglion
- b) Meissner plexus
- c) Auerbach plexus
- d) Sympathetic trunk
- e) Nucleus ambiguus of the CNS

**70) A 48-year-old man comes to your clinic presenting with epigastric pain that appears a short time after eating. While over-the-counter antacids worked well initially, the response is gradually fading. He admits that he is stressed at work.**

**Hypersecretion from which of the following cells is most likely responsible for his symptoms?**

- a) Chief cell
- b) Parietal cell
- c) Mucous neck cell
- d) Surface mucous cell
- e) Smooth muscle cell



**71) Which of the following cells is NOT present in the fundic gland?**

- a) Parietal cells
- b) Mucous neck cells
- c) Mucous alveolar cells
- d) Surface columnar cells
- e) Enteroendocrine cells

**72) Which of the following might occur if the cell in the photo was absent in an individual?**

- a) Anemia
- b) Jaundice
- c) Peptic ulcer
- d) Barrett's esophagus
- e) Adenoma

**73) The resting parietal cell does not secrete acid for which of the following reasons?**

- a) The  $\text{Na}^+$ ,  $\text{K}^+$  ATPase is inserted into the apical membrane.
- b) The chloride channel of the apical plasma membrane is closed.
- c) The  $\text{H}^+$ ,  $\text{K}^+$  ATPase is sequestered in tubulovesicles.
- d) Carbonic anhydrase is not produced.
- e) Histamine receptors are uncoupled from their second messenger.

**74) A 24-day-old infant presents with abdominal pain. His mother reports that he was suddenly unable to hold down any milk after 3 weeks of normal breastfeeding. She states that the infant forcefully vomits at ~ 20 minutes following every feeding. Which of the following layers is most likely pathologic in the infant?**

- a) Epithelium
- b) Muscularis mucosae
- c) Submucosa
- d) Inner circular smooth muscle layer
- e) Outer longitudinal smooth muscle layer

- 75) A 40 year old male presented with weakness, paresthesia and sores at the angle of the mouth. His blood picture showed that he had pernicious anemia. This is due to defect in which of the following?**
- a) Peptic cells
  - b) Paneth cells
  - c) Parietal cells
  - d) Enteroendocrine cells
  - e) Goblet cells
- 76) Enteroendocrine cells differ from goblet cells in which of the following ways?**
- a) Secretion by regulated pathway
  - b) Their origin from a crypt stem cell
  - c) The direction of release of secretion
  - d) Their presence in small and large intestine
  - e) The use of exocytosis for release of secretory product from the cell
- 77) Which of the following materials can be absorbed directly by the surface lining cells of the stomach?**
- a) Alcohol
  - b) Vitamin B12
  - c) Triglycerides
  - d) Chylomicrons
  - e) Polysaccharides
- 78) What are the most eosinophilic-stained cells of the fundic glands?**
- a) Cells stained by silver
  - b) Cells producing pepsinogen
  - c) Cells secreting soluble mucous
  - d) Cells producing alkaline mucous
  - e) Cells producing hydrochloric acid
- 79) 58-year-old woman with a history of indigestion after meals and “heartburn” presents with upper abdominal pain. She is currently being treated with proton pump inhibitors for gastroesophageal reflux disease (GERD). Which of the following types of epithelial cells has proton pumps and generates hydrochloric acid (HCl) within the lumen of the stomach?**
- a) Chief cells
  - b) Enterocytes
  - c) Goblet cells
  - d) Paneth cells
  - e) Parietal cells
- 80) Which of the following locations in the mucosa provides a niche for multipotent gastric stem cells?**
- a) Fundus of glandular epithelium
  - b) Gastric pit
  - c) Isthmus of glandular epithelium
  - d) Lamina propria
  - e) Neck of glandular epithelium



- 81) Certain antibiotic therapies slow the replacement of the cells lining the stomach. Which of the following is the target location of this drug?**
- a) Pit
  - b) Isthmus
  - c) Surface
  - d) Villous top
  - e) Crypt base
- 82) Regeneration of the deep part of the fundic gland is due to proliferation of cells characterized by which of the following?**
- a) Basal granules and apical microvilli.
  - b) Faint apical vacuolated cytoplasm.
  - c) Deeply acidophilic cytoplasm.
  - d) Apical electron dense granules.
  - e) Basophilic cytoplasm and many ribosomes
- 83) A 50 years old man presented to the clinic with an epigastric pain after meals. The history revealed taking proton pump inhibitor drugs for several days. The endoscopic examination revealed the presence of gastric ulcers.**
- What are the ultrastructure findings of the cells responsible for this case?**
- a) Apical ciliated surface
  - b) Intracellular canaliculi
  - c) Basal electron dense granules
  - d) Apical electron lucent granules
  - e) Apical electron dense granules
- 84) A 70-year-old man comes to the physician with abdominal pain and fatigue. Physical examination shows conjunctival and oral mucosal pallor, non-tender abdomen and no palpable masses. Upper GIT endoscopy shows diffuse damage of the fundic mucosa. The antral mucosa appears preserved. Serum studies shows the presence of antibodies directed against parietal cell components. Which of the following conditioned is most likely associated with these findings?**
- a) A decreased growth of luminal bacteria
  - b) Decreased likelihood of developing gastric carcinoma
  - c) Decreased plasma concentration of gastrin
  - d) Increased percentage of macrocytic blood cells
  - e) Increased secretion of pancreatic bicarbonate
- 85) Which one of the following is the predominant lining cell of the pyloric glands?**
- a) Chief cells
  - b) Goblet cells
  - c) Parietal cells
  - d) Mucous secreting cell
  - e) Enteroendocrine cells

**86) A 35-year-old man comes to the physician because of burning epigastric pain for the past 2 months. Physical examination shows no abnormalities. Upper GIT endoscopy shows several peptic ulcers. Further evaluation shows an elevated serum gastrin level. What is the characteristic of the cell responsible for this elevation?**

- a) Apical acidophilia and basal basophilia
- b) Apical vacuolated cytoplasm
- c) Infra-nuclear granules
- d) Diffuse free ribosomes
- e) Intracellular canaliculi

**87) Which of the following is present in the mucosa of the small intestine?**

- a) Mucous acini.
- b) Central lacteals.
- c) Myenteric plexus.
- d) Meissner's plexus.
- e) Striated muscle fibers.

**88) Which of the following uniquely characterizes the structure of the crypt base columnar cells?**

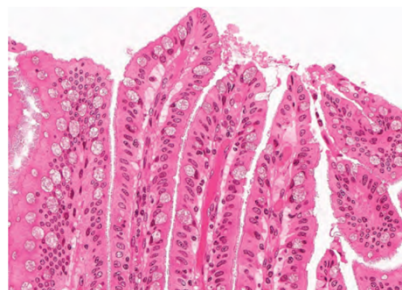
- a) Basal infoldings
- b) Apical brush border
- c) Numerous diffuse ribosomes
- d) Pocketing of the basal membrane
- e) Basal basophilia with apical acidophilia

**89) Which of the following features characterizes the lamina propria of the jejunum?**

- a) Peyer's patches
- b) Meissner plexus
- c) Central lacteals
- d) Auerbach plexus
- e) Brunner's glands

**90) A 70-year-old man undergoes chemotherapy for liver cancer, develops sepsis, and dies of multiorgan system failure. The patient's visceral organs are examined at autopsy. The plastic-embedded section shown in the image was obtained from what segment of the GI tract?**

- a) Stomach
- b) Appendix
- c) Esophagus
- d) Large intestine
- e) Small intestine



**91) Examination of the lamina propria of the ileum reveals which of the following key histologic features of the GI tract?**

- a) Lacteals
- b) Mucous glands
- c) Brunner glands
- d) Meissner plexuses
- e) Myenteric plexuses

**92) A 52-year-old man is diagnosed with a carcinoid. The cells responsible for producing this disorder differ from goblet cells in which of the following?**

- a) The origin from a crypt stem cell
- b) The direction of release of secretion
- c) Their location in a simple columnar epithelium
- d) Their presence in the small and large intestines
- e) The use of transcytosis for release of secretory product

**93) A 2-year-old infant presented to the clinic with diarrhea for 2 days after being newly introduced to drink a cup of sterilized cow milk. On examination, the abdomen was distended and painful on percussion.**

**Which of the following normally characterizes the affected cell?**

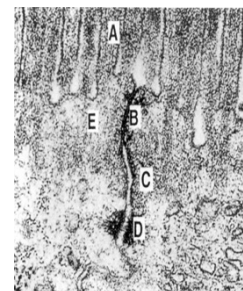
- a) Basal terminal web
- b) Very little Golgi complex
- c) Brush border of microvilli
- d) Few smooth endoplasmic reticulum
- e) Absence of Rough endoplasmic reticulum

**94) Which of the following is NOT a characteristic feature of enterocytes?**

- a) Abundant mitochondria.
- b) Junctional complexes.
- c) Numerous microvilli.
- d) Basal infoldings.
- e) Covered by glycocalyx.

**95) Regarding the accompanying TEM photo, which area is most likely damaged in Celiac disease?**

- a) Area A
- b) Area B
- c) Area C
- d) Area D
- e) Area E



**96) Which of the following is characteristic to the absorptive cells of the small intestine?**

- a) Have apical brush border
- b) Have intracellular canaliculi
- c) Also called enteroendocrine cells
- d) Have many microvilli covering their basal surfaces
- e) Undergo mitosis at tips of villi and are sloughed off into crypts

**97) Renewal of epithelium of small intestine depends on which cell of the following?**

- a) Paneth cells.
- b) Argrophil cells.
- c) Oligomucous cells.
- d) Goblet cells.
- e) Crypt base columnar cells.

**98) The small intestine has three histologically distinct regions. Which of the following statements concerning the histological differences in the three regions is true?**

- a) Peyer patches are present only in the ileum.
- b) Goblet cells are present only in the epithelium of the duodenum
- c) Brunner glands are located in the duodenum and jejunum but not the ileum
- d) Lacteals are present only in the lamina propria of the ileum
- e) The muscularis mucosae contains three layers of smooth muscle in the ileum and two layers in the duodenum and jejunum.

**99) During the digestion, which of the following helps regulate the bacterial content of the small intestine?**

- a) Cells of the Brunner's glands
- b) M cells
- c) Paneth cells
- d) Gastrin producing cells in duodenum
- e) Peyer's patches

**100) Certain antibiotic therapies slow the replacement of the cells lining the small intestine. This may cause the loss of what tissue type?**

- a) Ciliated pseudostratified columnar epithelium
- b) Simple cuboidal epithelium
- c) Simple columnar epithelium
- d) Pseudostratified columnar epithelium with stereocilia
- e) Stratified squamous, nonkeratinized epithelium

**101) Secretin and cholecystokinin are produced and secreted by cells in the lining of the alimentary tract. Which of the following statements about these two substances is true?**

- a) They are produced by diffuse neuroendocrine cells (DNES cells) in the lining of the stomach and small intestine
- b) They are digestive enzymes present within the lumen of the duodenum
- c) They are produced by Paneth cells
- d) They are hormones that have target cells in the esophagus
- e) They are produced by Brunner glands and released into the lumina of the crypts of Lieberkühn

**102) Which of the following is true about the absorptive columnar cells?**

- a) Also called enteroendocrine cells
- b) Have many microvilli covering their basal surface
- c) Absorb lipid by active transport
- d) Synthesize triglycerides from absorbed lipids
- e) Undergo mitosis at tips of the villi and sloughed off at tips of the crypts



**103) Which of the following would most likely result from a reduction in the number of Paneth cells?**

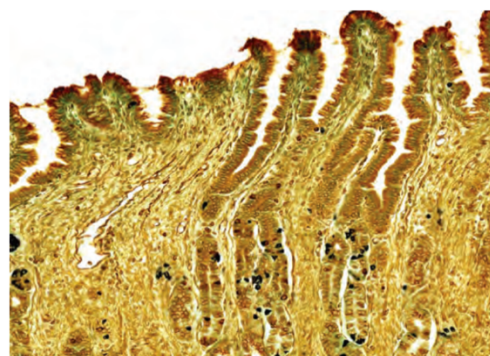
- a) Thinning of the glycocalyx
- b) Reduced breakdown of fats
- c) Decreased mucus in the intestine
- d) Elevated levels of undigested proteins
- e) Increased number of intestinal bacteria

**104) Membrane like epithelial cells are characterized by which of the following?**

- a) Having many lysosomes.
- b) Being tall columnar cells.
- c) Having apical brush border.
- d) Being identified by silver stain.
- e) Having basal membrane pockets.

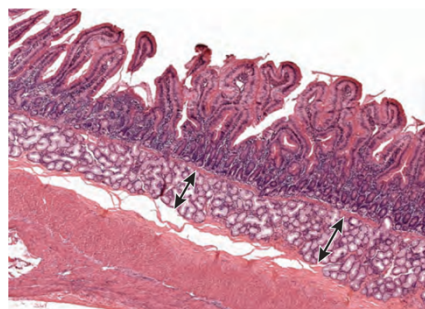
**105) A silver stain is used to identify enteroendocrine cells in the pyloric region of the stomach (small dark-stained cells, shown in the image). These argentaffin cells are classified as “open” or “closed” depending on whether or not their apical membranes reach the lumen of the gut. What is the primary function of “open” enteroendocrine cells in the GI tract?**

- a) Antibody secretion
- b) Antigen uptake
- c) Chemoreception
- d) Gastrin secretion
- e) Histamine release



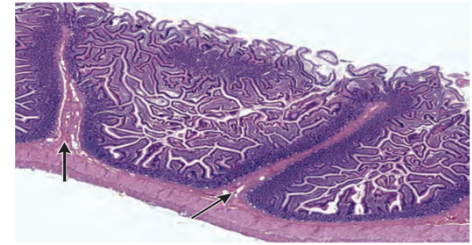
**106) Various organs of the GI tract are examined in the histology laboratory. Identify the glandular structures located between the double arrows (shown in the image).**

- a) Fundic glands
- b) Pyloric glands
- c) Brunner glands
- d) Cardiac glands
- e) Intestinal glands



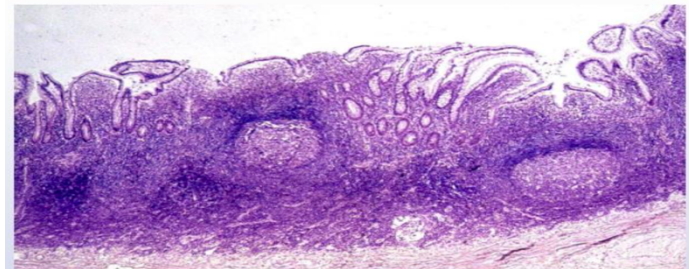
107) A 68-year-old man with a history of intestinal malabsorption suffers a stroke and expires. Portions of the patient's small intestine are collected at autopsy, stained with H&E, and examined at low magnification. Identify the distinctive submucosal folds indicated by the arrows (shown in the image).

- a) Haustra
- b) Plicae circulares
- c) Rugae
- d) Teniae coli
- e) Villi



108) A patient with gastrointestinal bleeding undergoes both esophagogastroduodenoscopy and colonoscopy with visualization of distal small intestine. The tissue biopsied have the appearance showed in the micrograph. Which of the following is the most likely site of this biopsy?

- a) Stomach
- b) Duodenum
- c) Jejunum
- d) Ileum
- e) colon



109) A 25-year-old healthy volunteer participates in a nutritional research study. After participants ingests a very fatty meal, serum samples are taken at 1 hour and 3 hours. The diameter of the chylomicron is measured showing an average chylomicron diameter of 500 nm at 1 hour, which decreases at an average diameter of 150 nm at 3 hours. What are the characteristic features of the cell that produce chylomicron?

- a) Basal brush border
- b) Lateral interdigitations
- c) Numerous SER
- d) Few mitochondria
- e) Few Golgi complexes

110) A 25-year-old healthy volunteer participates in a nutritional research study. After participants ingests a very fatty meal, serum samples are taken at 1 hour and 3 hours. The diameter of the chylomicron is measured showing an average chylomicron diameter of 500 nm at 1 hour, which decreases at an average diameter of 150 nm at 3 hours. At which of the following locations is the enzyme responsible for this change in chylomicron diameter most likely present?

- a) Adipocytes
- b) Endothelial cells
- c) Enterocytes
- d) Hepatocytes
- e) Myocytes

- 111) A 4-year-old boy is brought to the emergency department by his parents after they observed him ingest a small plastic toy building block. The parents are reassured to learn that the plastic block will most likely be eliminated by the normal bowel movement, and if not, will be forced through the GI tract during one of the periodic sequential contractions that begin to the stomach and gradually migrate to the ileum during fasting. Release of which of the following intestinal hormones is most likely responsible for this periodic event?**
- a) Cholecystokinin
  - b) Gastrin
  - c) Gastrin-releasing peptide
  - d) Motilin
  - e) Secretin
  - f) Somatostatin
- 112) A 4-year-old boy is brought to the emergency department by his parents after they observed him ingest a small plastic toy building block. The parents are reassured to learn that the plastic block will most likely be eliminated by the normal bowel movement, and if not, will be forced through the GI tract during one of the periodic sequential contractions that begin to the stomach and gradually migrate to the ileum during fasting by the action of Motilin. Which of the following is a feature of the cell responsible for this hormone release?**
- a) Have a brush border
  - b) Can be stained by silver
  - c) Can be seen by H&E
  - d) Have apical dense granules
  - e) Absent in the stomach
- 113) A first-year medical student seeks help to identify lymphoid follicles. In addition to abundant aggregation of lymphoid follicles, there more prominent villi. Which of the following structures might she also be able to identify using the same slide?**
- A. Submucosal glands
  - B. Plicae circulares
  - C. Epiploic appendages
  - D. Tenia coli
  - E. Oxyntic cells
- 114) A biopsy was taken from the duodenum in a patient suffering intractable duodenal ulcer. Examination of the lamina propria reveals which of the following key histologic features?**
- a) Brunner glands
  - b) Lacteals
  - c) Meissner plexuses
  - d) Myenteric plexuses
  - e) Pyloric glands

- 115) A biopsy was taken from the duodenum in a patient suffering intractable duodenal ulcer. Examination of the submucosa reveals which of the following key histologic features?**
- a) Brunner glands
  - b) Lacteals
  - c) Meissner plexuses
  - d) a & b
  - e) a & c
- 116) A 35-year-old complains of bloating, cramping abdominal pain, diarrhea with excessive flatulence after milk ingestion. In this disorder, there is defect in specific disaccharidase activity. Which of the following cells is affected?**
- a) Goblet cells
  - b) Paneth cells
  - c) Enteroendocrine cells
  - d) Enterocytes
  - e) M cells
- 117) A biopsy obtained during endoscopy revealed simple columnar cells lining, deep pits consisting of mucus-secreting cells, and well-defined layers of smooth muscles. A smaller portion of the slide revealed goblet cells, villi, and submucosal glands. Which is the most likely segment of the GI that is being examined?**
- a. Gastroesophageal junction
  - b. Ileocecal junction
  - c. Gastroduodenal junction
  - d. Pharyngo-esophageal junction
  - e. Recto-anal junction
- 118) In a small intestinal biopsy obtained during endoscopy, which of the following is characteristic to the cell in the very base of the crypt?**
- A. Acidophilic cytoplasm containing HCl
  - B. Basophilic cytoplasm rich in free ribosomes
  - C. Basal secretory granules containing secretin
  - D. Apical secretory granules containing lysozymes
  - E. Apical mucinogen granules
- 119) In an intestinal villus, which of the following layers contain abundant macrophages and lymphocytes?**
- a. Epithelium of mucosa
  - b. Lamina propria
  - c. Muscularis externa
  - d. Muscularis mucosae
  - e. Submucosa

- 120) In an intestinal villus, antigen sampling cells covering Peyer's patches are characterized by which of the following?**
- a. Flat with basal pocket
  - b. Columnar with apical microvilli
  - c. Pyramidal with basal basophilia
  - d. Rounded with intracellular canaliculi
  - e. Cuboidal with numerous lysosomes
- 121) A 35-year-old complains of bloating, cramping abdominal pain, diarrhea with excessive flatulence after milk ingestion. In this disorder, there is defect in the apical microvilli, with a resulting decrease in which one of the following?**
- a. Specific disaccharidase activity
  - b. Glucose/galactose transporter activity
  - c. Passive diffusion of monosaccharides
  - d. Uptake of triglycerides by endocytosis
  - e. Active transport of glycerol
- 122) A 35-year-old complains of bloating, cramping abdominal pain, diarrhea with excessive flatulence after milk ingestion. In this disorder, there is defect in specific disaccharidase activity. Which of the following is characteristic to the affected cells?**
- a. Apical mucous granules
  - b. Basal secretory granules
  - c. Connection by junctional complexes
  - d. Basal membrane infoldings
  - e. Intracellular canaliculi
- 123) Which of the following statements applies to the exocrine pancreas?**
- a) Well-developed myoepithelial cells
  - b) Striated ducts can be numerous seen
  - c) Has thick septa with prominent fat cells
  - d) Basophilic cells with acidophilic zymogen granules
  - e) Stratified squamous epithelium lines the main pancreatic duct
- 124) Which description of the following applies to most of the pancreatic zymogens?**
- a) Are synthesized by free ribosomes
  - b) Are packaged for secretion in the SER
  - c) Are stored in the basal cytoplasm of acinar cells
  - d) Are inactive until they reach the duodenal lumen
  - e) Are produced by cuboidal cells lining the pancreatic duct
- 125) Which feature is unique to the exocrine pancreas?**
- a) Centroacinar cells
  - b) Insulin-secreting  $\beta$  cells
  - c) Striated interlobular ducts
  - d) Striated intralobular ducts
  - e) Predominately serous secretory cells



- 126) Which one of the following structures is responsible for basophilia in pancreatic acinar cells?**
- a. Golgi apparatus
  - b. Zymogen granules
  - c. Smooth endoplasmic reticulum
  - d. Rough endoplasmic reticulum
  - e. Glycogen granules
- 127) Which of the following best describes the stroma of the pancreas?**
- a) It is thick and coarse
  - b) It is thin and delicate
  - c) It contains many fat cells
  - d) It has many striated ducts
  - e) It contains numerous elastic fibers
- 128) Which of the following is a characteristic feature of pancreatic acinar cells?**
- a) Basal granules
  - b) Few ribosomes
  - c) Numerous SER
  - d) Many lysosomes
  - e) Prominent Golgi
- 129) A 45-year-old woman presents with a mass affecting the head of the pancreas. She was treated with a partial pancreaticoduodenectomy. The biopsy taken from the surgical specimen is being examined. Which of the following is true regarding the centroacinar cells?**
- a) Produce bile
  - b) Remove sodium from the pancreatic exocrine secretion
  - c) Secrete insulin
  - d) Secrete enzymes for protein digestion
  - e) Adds  $\text{HCO}_3^-$  to pancreatic exocrine secretion
- 130) A 50-year-old man presented with malabsorption syndrome as a result of chronic pancreatitis with the result of failure of the pancreatic exocrine function. What is the characteristic feature of this part of pancreas?**
- a) Contain seromucinous mixed cells
  - b) Centroacinar cells are found in the acini
  - c) Acinar cells have well distinct boundaries
  - d) Prominent striated ducts
- 131) Which of the following best differentiates the pancreas from the parotid gland?**
- a) Numerous serous acini
  - b) Few mucous acini
  - c) Absent striated ducts
  - d) Formed of lobules
  - e) Less lobules

- 132) A 35-year-old woman presents with abdominal pain and diarrhea especially after eating gluten containing diet. Biopsy obtained showed cell with short microvilli. Which of the following is the character of the affected cells?**
- a. Contain basal infoldings and mitochondria
  - b. Rich in both RER and SER
  - c. Basal secretory granules
  - d. Apical mucin granules
  - e. Rich in free ribosomes
- 133) A 52-year-old man is diagnosed with carcinoid after an appendectomy. The enteroendocrine cells producing this disorder differ from goblet cells in which of the following?**
- a) The direction of release of secretion
  - b) The use of exocytosis for release of secretory products
  - c) The presence in small and large intestine
  - d) The origin from a crypt stem cell
  - e) Their location in a simple columnar epithelium
- 134) Diarrhea may result if a specific cell fails to carry out its role in absorbing water from the feces. Which is the characteristic TEM feature of this cell?**
- a) Apical cilia
  - b) Basal terminal web
  - c) Lateral junctional complex
  - d) Apical electron dense granules.
  - e) Basal electron dense granules.
- 135) Which of the following is the cause of the abundance of the goblet cells in the colon?**
- a) More water absorption
  - b) Lubrication of hard feces
  - c) Storage of vitamin A
  - d) Decrease gut motility
  - e) Secretion of gastrin
- 136) The tenia coli of the large intestine represent an organ-specific specialization of which layer of the intestinal tract wall?**
- a) Serosa
  - b) Epithelium
  - c) Lamina propria
  - d) Muscularis mucosa
  - e) Muscularis externa
- 137) Disturbance in GIT motility encountered in Hirschsprung disease is the result of which of the following?**
- a) Constricted areas in some segments of the colon
  - b) Hypersecretion of submucosal glands
  - c) Hypersecretion of mucosal glands
  - d) Loss of longitudinal folds of esophageal wall
  - e) Absence of neurons of enteric nerve plexuses

**138) At the rectoanal junction, the internal anal sphincter is formed by thickening of which of the following structures?**

- a) Both layers of muscularis externa
- b) Inner circular layer of muscularis mucosa
- c) Inner circular layer of muscularis externa
- d) Outer longitudinal layer of muscularis externa
- e) Outer longitudinal layer of muscularis mucosa

**139) A patient goes to the emergency department, and the physician notes one of the classic symptoms of appendicitis. Which of the following is true about the affected organ?**

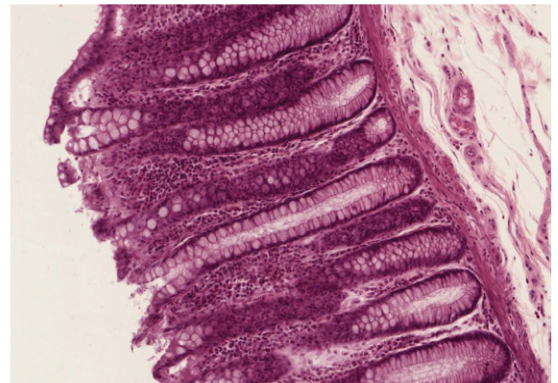
- a) Shows tenia coli
- b) Shows leaf-like villi
- c) Has few shallow crypts
- d) Has numerous goblet cells
- e) Contains abundant fat cells in serosa

**140) A tissue sample reveals simple columnar epithelium, straight and unbranched tubular glands extending through the full thickness of the mucosa, and extensive goblet cells. A thorough search failed to demonstrate villi. Which of the following areas is probably the source for the sample?**

- a) Esophagus
- b) Fundic stomach
- c) Duodenum
- d) Ileum
- e) Transverse colon

**141) Which of the following statements concerning the histological structure of the organ in the figure is correct?**

- a) The mucosal lining is composed of simple squamous cells.
- b) Goblet cells form a large proportion of the mucosal cells.
- c) Villi significantly increase the mucosal surface area.
- d) Glands traverse less than half the thickness of the mucosa.
- e) Longitudinal muscle fibers are absent in the wall

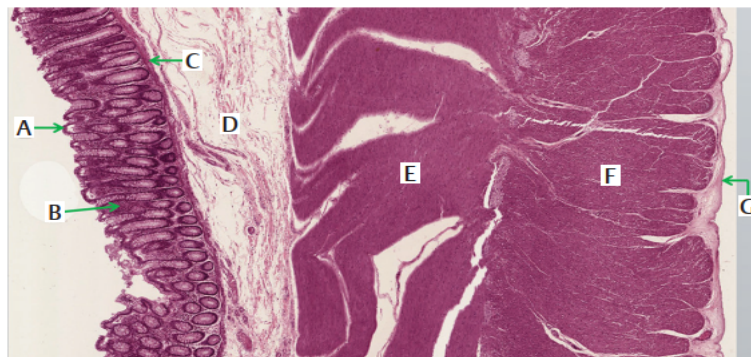


**142) A transition from simple columnar epithelium with simple tubular glands (predominant cells are goblet) to nonkeratinized stratified squamous epithelium is revealed in a histological slide. Based on the tissue types, which part of the GI tract is under examination?**

- a. Junction of the esophagus and cardia of the stomach
- b. Junction of the pylorus of stomach and duodenum
- c. Junction of the excretory duct of the salivary glands and oral cavity
- d. Junction of the sigmoid colon and rectum
- e. Pectinate line of the anal canal

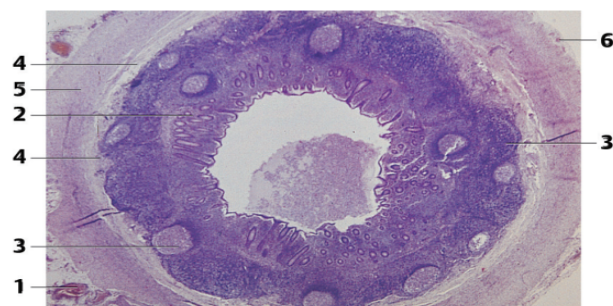
143) A 60-year-old man underwent laparoscopically assisted subtotal colectomy. A biopsy obtained from the surgical specimen is seen in the figure. Tenia coli, sacculations, and epiploic appendages are unique to the large intestine. In which of the following layers are tenia coli represented?

- A. C
- B. B and C
- C. E
- D. F
- E. E and F



144) A 20-year-old man presents with severe pain in his abdomen. A biopsy obtained from the surgically removed inflamed organ is found in the figure. Which of the following is true for the organ?

- a) It might have both skeletal and smooth muscles in its wall.
- b) It might have both mucosal and submucosal glands in its wall.
- c) It has deep long mucosal crypts
- d) Have numerous goblet cells
- e) Gut associated lymphatic tissue is present all around

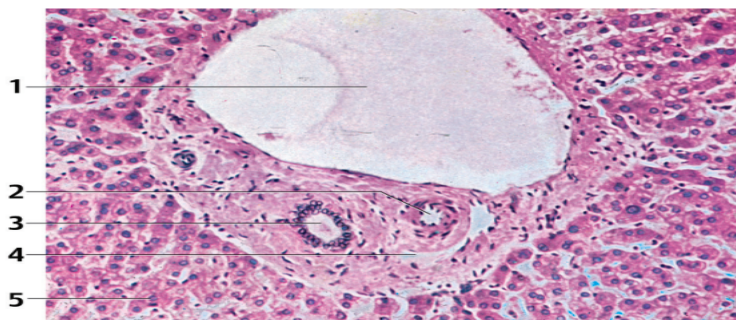


145) Bile, produced by hepatocytes, is carried to the alimentary tract by intrahepatic and extrahepatic biliary channels. Which of the following is true for the segment of the GI tract where bile first enters?

- a. It has a stratified surface epithelium.
- b. It is identified by aggregated lymphoid follicles that surround the entire lumen.
- c. It is identified by aggregated lymphoid follicles that are restricted to a side of the lumen.
- d. It is identified by expansion of its circular smooth muscle layer.
- e. It is identified by the submucosal glands.

146) While reviewing histology slides before the block final, you pull out the slide (image) from a box labeled "gastrointestinal organs." Which of the following structures is a component of the intrahepatic biliary apparatus?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5



**147) In the previous figure, which of the following structures synthesizes bile?**

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

**148) A 54-year-old man presents with a history of constant right upper-quadrant abdominal pain and persistent fever and chills. An abdominal ultrasound demonstrates a mass in the right liver lobe. Segmental resection of the right lobe was performed. A biopsy obtained from the specimen is being examined. Which of the following is the site for exchange of material between the hepatocyte and the hepatic sinusoid?**

- a. Space of Disse
- b. Endothelium
- c. Bile canaliculi
- d. Central vein
- e. Portal area

**149) A 29-year-old man complains to his physician of chronic diarrhea. On further questioning he reveals that the diarrhea is watery and intermittent, and that he also suffers from flatulence and weight loss of 3.6 kg (8 lb) over the past year. He denies fever, nausea, vomiting, abdominal pain, and recent travel. Stool examinations for ova and parasites and for occult blood are negative, and stool culture does not grow any pathogens. Endoscopy is performed and biopsy of the upper part of the small intestine demonstrates diffuse blunting of villi and a chronic inflammatory infiltrate in the lamina propria. Which therapeutic option will most likely benefit this patient?**

**In a liver biopsy from a long-time drug user which of the following hepatocyte organelles would be expected to be more extensive than normal?**

- a) Lysosomes
- b) Proteasomes
- c) Golgi apparatus
- d) Rough endoplasmic reticulum
- e) Smooth endoplasmic reticulum

**150) Which of the following is NOT a component of the portal tract?**

- a) Branch of the hepatic artery
- b) Branch of the portal vein
- c) Branch of the bile duct
- d) Lymphatics and nerves
- e) Branch of portal artery

**151) Hepatocytes in zone 1 are characterized by which of the following?**

- a) They have the best blood supply
- b) They have the least blood supply
- c) They have the least glucose supply
- d) They lie in close proximity to the central vein
- e) They are the most active in drug metabolism



**152) Which of the following best explains the vacuolation detected in hepatocytes by LM?**

- a) Numerous mitochondria.
- b) Abundant peroxisomes.
- c) Fat & glycogen granules.
- d) Well-developed RER.
- e) Heterolysosome.

**153) Which of the following is true concerning the liver classifications?**

- a) A central vein forms the center of the portal lobule
- b) A vascular core forms the center of the liver acinus
- c) Portal tracts form the periphery of the portal lobule
- d) Portal tracts form the center of the classic hepatic lobules
- e) A central core of combined portal area and center vein is encountered

**154) Which of the following is NOT a characteristic feature of Von Kupffer cells?**

- a) Fenestrations and pores
- b) Numerous lysosomes
- c) Pseudopodia
- d) Phagocytic vesicles

**155) Which one of the following biliary passages is present in the portal tract?**

- a) Bile canaliculus
- b) Herring canal
- c) Preductule
- d) Bile ductule
- e) Bile duct

**156) The bile canaliculus is lined by which of the following cells?**

- a) Cubical cells
- b) Hepatocytes
- c) Columnar cells
- d) Cholangiocytes
- e) Kupffer cells

**157) The portal lobule is best known by which of the following?**

- a) Its diamond shape
- b) Its central vascular core
- c) Drainage of bile towards its center
- d) Presence of portal areas in all its angles
- e) Its endocrine function of the hepatocytes

**158) Which of the following applies to the space of Disse?**

- a) Is located in the portal areas
- b) Is sealed by junctional complexes
- c) Is directly contacted by hepatocytes
- d) Contents flow toward the central vein
- e) Contents empty into canals of Herring lined by cholangiocytes

**159) The hepatocyte's surface facing the space of Disse is characterized by presence of which of the following structures?**

- a) Reticular fibers
- b) Numerous long microvilli
- c) Numerous pseudopodia
- d) Junctional complexes and gap junctions
- e) Direct contact with the endothelium

**160) Which cell is considered as a component of the space of Disse?**

- a) Ito cell
- b) Endothelium
- c) Hepatocyte
- d) Kupffer cell
- e) Cholangiocyte

**161) Which of the following is characteristic to hepatic blood sinusoids?**

- a) They have sieve plate fenestrae
- b) They are lined by hepatic stellate cell
- c) They are present exclusively in zone (I)
- d) They have direct contact with hepatocytes
- e) They receive blood from central vein

**162) Which description of the following is true about the bile canaliculi?**

- a) Are part of the portal triad
- b) Normally contain some blood plasma
- c) Are surrounded by the hepatic sinusoids
- d) Are bordered directly by endothelial cells
- e) Lumens are entirely sealed by junctional complexes

### Answers

- |       |       |
|-------|-------|
| 1- B  | 46- A |
| 2- D  | 47- E |
| 3- D  | 48- A |
| 4- B  | 49- D |
| 5- A  | 50- B |
| 6- D  | 51- B |
| 7- E  | 52- D |
| 8- D  | 53- E |
| 9- E  | 54- D |
| 10- B | 55- B |
| 11- C | 56- D |
| 12- B | 57- E |
| 13- D | 58- E |
| 14- B | 59- E |
| 15- E | 60- A |
| 16- B | 61- B |
| 17- A | 62- E |
| 18- C | 63- C |
| 19- A | 64- E |
| 20- D | 65- D |
| 21- C | 66- D |
| 22- D | 67- E |
| 23- B | 68- E |
| 24- D | 69- B |
| 25- E | 70- B |
| 26- C | 71- C |
| 27- E | 72- A |
| 28- B | 73- C |
| 29- C | 74- E |
| 30- B | 75- C |
| 31- D | 76- C |
| 32- B | 77- A |
| 33- C | 78- E |
| 34- B | 79- E |
| 35- C | 80- C |
| 36- A | 81- B |
| 37- C | 82- E |
| 38- D | 83- D |
| 39- B | 84- D |
| 40- D | 85- B |
| 41- B | 86- C |
| 42- B | 87- B |
| 43- C | 88- C |
| 44- D | 89- C |
| 45- C | 90- E |

- |        |        |
|--------|--------|
| 91- A  | 127- B |
| 92- B  | 128- E |
| 93- C  | 129- E |
| 94- D  | 130- B |
| 95- A  | 131- C |
| 96- A  | 132- B |
| 97- E  | 133- A |
| 98- A  | 134- C |
| 99- C  | 135- B |
| 100- C | 136- E |
| 101- A | 137- E |
| 102- D | 138- C |
| 103- E | 139- C |
| 104- E | 140- E |
| 105- C | 141- B |
| 106- C | 142- E |
| 107- C | 143- D |
| 108- D | 144- E |
| 109- C | 145- E |
| 110- B | 146- E |
| 111- D | 147- A |
| 112- B | 148- E |
| 113- B | 149- E |
| 114- B | 150- A |
| 115- E | 151- C |
| 116- D | 152- B |
| 117- C | 153- A |
| 118- D | 154- D |
| 119- B | 155- B |
| 120- A | 156- C |
| 121- A | 157- C |
| 122- C | 158- B |
| 123- D | 159- A |
| 124- D | 160- A |
| 125- A | 161- E |
| 126- D |        |

**Training on Histology essay questions in GIT**

**Enumerate (List/ mention):**

**1- The types of oral mucosa.**

*a- Masticatory mucosa.*

- b- Lining mucosa.*
  - c- Specialized mucosa.*
- 2- The lingual papillae.**
  - a- Filiform papillae.*
  - b- Fungiform papillae.*
  - c- Circumvallate papillae.*
  - d- Foliate papillae.*
- 3- Components of the taste bud.**
  - a- Neuroepithelial cells (gustatory/sensory cells).*
  - b- Supporting cells.*
  - c- Basal Stem cells.*
- 4- Components of stroma of the salivary glands.**
  - a- Capsule.*
  - b- Trabeculae (septa).*
  - c- Reticular connective tissue.*
- 5- The duct system of the salivary glands.**
  - a- Intralobular ducts: intercalated ducts & striated ducts.*
  - b- Interlobular ducts.*
  - c- Main duct.*
- 6- Parts of the fundic gland.**
  - a- Isthmus.*
  - b- Neck.*
  - c- Base.*
- 7- The cell lining the fundic gland.**
  - a- Surface mucous secreting columnar cells.*
  - b- Mucous neck cells.*
  - c- Parietal cells.*
  - d- Stem cells.*
  - e- Chief cells.*
  - f- Enteroendocrine cells.*
- 8- Factors augmenting the absorption capabilities of the small intestine.**
  - a- Plicae circularis.*
  - b- Villi.*
  - c- Microvilli.*
- 9- The cells lining the intestinal villi.**
  - a- Columnar absorptive cells (Enterocytes).*
  - b- Goblet cells.*
  - c- Enteroendocrine cells.*



**10- The cells lining the small intestinal crypts.**

- *Upper half of the crypts:*
  - a- *Enterocytes.*
  - b- *Goblet cells.*
  - c- *Enteroendocrine cells.*
- *Lower half of the crypts:*
  - a- *Paneth cells.*
  - b- *Crypt base columnar cells (stem cells).*
  - c- *Membrane-loke epithelial cells (M cells).*

**11- Organelles involved in fat absorption (in order).**

- a- *Smooth endoplasmic reticulum.*
- b- *Golgi apparatus.*
- c- *Rough endoplasmic reticulum*
- d- *Basolateral cell membrane*

**12- Content of the core of small intestinal villi.**

- a- *Loose C.T. Extending from the lamina propria, containing lymphocytes, plasma cells and macrophages.*
- b- *Central lymphatic lacteals.*
- c- *Smooth muscle fibers extend from Muscularis Mucosa to surround the lacteals, and extend up to the tip of the villus.*
- d- *Fenestrated blood capillaries*

**Give reason for the following:**

**1- Red colour of the vermillion border.**

*Due to the presence of numerous highly vascular deep dermal papillae that reflect through the transparent very thin stratified squamous keratinized epithelium.*

**2- Muscularis externa of the upper part of the esophagus is formed of skeletal muscle.**

*To initiate the process of deglutition (swallowing) voluntarily.*

**3- Intercalated ducts of the salivary glands have special importance.**

*Because their cells are stem cells that have the ability to divide and differentiate into secretory or ductal cells.*

**4- Presence of acidophilic striation in the striated ducts of salivary glands.**

*Because they have basal membrane infoldings (containing Na- K pumps) together with longitudinal mitochondria.*

**5- Surface of stomach is protected from the secreted acid.**

*Because surface mucous secreting cells of the stomach secrete thick, adherent, highly viscous, visible mucous, that is highly alkaline because it is rich in bicarbonate. So, this mucous form a gel coat to protect mucosa from HCL & rough intraluminal food.*

**6- Brunner's glands are present in the duodenum.**

*They secrete alkaline mucous necessary for:*

- 1- *Maintaining optimum pH for pancreatic enzymes activation.*
- 2- *Neutralizing the acidic chyme reaching the duodenum, thus protects its epithelial lining.*
- 7- **Basal granules are present in the enteroendocrine cells.**  
*To secrete their content of hormones into the blood capillaries present near the basal membrane in the connective tissue of the lamina propria.*
- 8- **Presence of plicae circularis in the small intestine.**  
*To increase the absorption capabilities of the small intestine by 3 folds.*
- 9- **Deeply acidophilic cytoplasm of the parietal cells.**  
*Due to presence of numerous mitochondria giving the energy necessary for HCL secretion.*
- 10- **Presence of microvilli in the intracellular canaliculi of parietal cells.**  
*To increase the surface area of the cell membrane for HCL secretion.*
- 11- **Goblet cells are more numerous as we go down the GIT tube.**  
*To lubricate the gut lumen by the secreted mucous and protect it from the hard faeces after water absorption from it.*
- 12- **Extensive RER is present in Paneth cells.**  
*For synthesis of the lysozymes which are protein in nature.*
- 13- **Brush border is seen in the enterocytes by PAS.**  
*Due to presence of regularly arranged microvilli with its covering of cell coat containing carbohydrates (glycocalyx).*
- 14- **Tips of filiform lingual papillae are pointed backwards.**  
*To prevent the food from spilling out of the mouth and facilitate the food movement during chewing.*
- 15- **Presence of Von Ebner's glands in association with the circumvallate papillae.**
  - a- *To wash and Clear the grooves which encircle the papillae.*
  - b- *Contains lipase enzyme to Prevent formation of a hydrophobic film that would hinder gustation.*
- 16- **Presence of myoepithelial basket cells around mucous acini.**  
*To contract by their content of actin & myosin and move the secretion towards the ducts.*

**Answer the following questions:**

**1. Describe the structure and correlated functions of parietal cell.**

*Site: In upper half of gastric glands (mainly in neck), fewer in the base.*

*LM: - Rounded or pyramidal.*

*- Deeply acidophilic*

*- Nucleus: rounded central vesicular, may be binucleated.*

*EM:*

- *Abundant mitochondria (giving the acidophilia in LM) to give energy for the process of HCL secretion.*

- *Intracellular canaliculi: deep invagination of the apical plasma membrane that shows microvilli to increase the surface area of the plasma membrane for HCL & intrinsic factor secretion*
- *Tubulovesicular system surrounding the canaliculi, acting as a reservoir for the intracellular canaliculi and microvilli.*
- *Little RER, small Golgi complex.*

## 2. Describe the structure of Paneth cells correlated to its functions.

- **Site:** *Present in groups, at the base of crypts only*
- **LM:**
  - *Cytoplasm: basal deep basophilia, apical acidophilic zymogen granules*
  - *Nucleus: rounded, basal, vesicular*
- **EM:**
  - *Apical secretory zymogen granules*
  - *Supranuclear Golgi complex*
  - *Abundant basal rER*
  - *Abundant mitochondria*

*The granules contain the synthesized Lysozymes (anti-bacterial) and Defensin proteins which are both produced by the extensive RER and packed by the supranuclear Golgi. And this process needs a lot of energy provided by the numerous mitochondria apparatus to be stored in the apical part of the cytoplasm until secreted.*

## 3. Describe the structure of the esophagus.

### a- Mucosa:

- *Epithelium: stratified squamous non keratinized epithelium.*
- *Lamina propria: loose connective tissue containing mucous glands in its upper & lower parts + gut-associated lymphatic tissue (GALT).*
- *Muscularis mucosa: smooth muscles arranged in thin inner circular and outer longitudinal muscle layers.*

### b- Submucosa: *Connective tissue containing mucous glands + Meissner's plexus of nerves.*

### c- Muscularis externa:

*Arranged in inner circular and outer longitudinal muscle layers with myenteric plexus of nerves in-between.*

*The muscle type differs along the length of the esophagus:*

- *Upper third → skeletal muscle fibers.*
- *Middle third → mixture of smooth & skeletal muscle fibers.*
- *Lower third → smooth muscle fibers.*

### d- Adventitia and serosa:

*Esophagus is mainly covered by adventitia, except below the diaphragm, it is covered with serosa.*

## 4. Describe the structure of the red margin of the lip.

*1- It is composed of modified skin:*

- *Very thin transparent Stratified squamous keratinized epithelium.*

- No sweat nor salivary glands.
- No hair follicles.
- No sebaceous glands.

2- Numerous deep highly vascular dermal papillae giving a pink color.

3- Rich in nerves.

## 5. Describe the structure of microfold cell.

Site: Between the epithelial cells of ileum overlying Peyer's patches.

L.M.: Cannot be distinguished because they are very thin & stretched.

EM:

- Apical border: Dome shaped and show few microvilli.
- Basal part: show numerous basal membrane invaginations, forming pockets containing intraepithelial lymphocytes & macrophages.
- Lateral borders: joined with the neighboring columnar cells by junctional complexes.
- Cytoplasm: contains few lysosomes.

## 6. Describe the histological structure of myoepithelial cells.

- They are present between plasma membrane of secretory cells and basal lamina and form hemidesmosomes with it. Also present around cells of proximal part of duct system.
- They are contractile as they contain cytoplasmic actin and myosin.
- Numerous processes surrounding the acini.

## 7. Describe the histological structure of enteroendocrine cells.

Site: scattered in the epithelium of stomach and intestine.

LM: - Not well distinguished by H&E.

1. Can be seen by silver (so they are called argentaffin cells), chromium (so called enterochromaffin cells), and by immunohistochemistry.

EM: There are 2 types:

a) Open type: reach the lumen and have apical microvilli (may act as chemoreceptors).

b) Closed type: do not reach the lumen.

Both types have basal secretory granules

**Compare between the following structures (in a table form):**

### a- Different types of lingual papillae.

	<b>Filiform</b>	<b>Fungiform</b>	<b>Circumvallate</b>	<b>Foliate</b>
<b>Site</b>	Transverse rows parallel to sulcus terminalis	Scattered	One row just in front of sulcus terminalis	More in young persons & rudimentary in old age
<b>Shape</b>	Conical with their tips pointing backwards	Mushroom; broad apex, narrow base	Narrow base, surrounded by trough	Rectangular, parallel ridges, groove
<b>Number</b>	Numerous	Few	8 - 12	present in young

<b>Covering epith.</b>	St. sq. Keratinized (white or gray)	St. sq. non Keratinized (red)	St. sq. non Keratinized	St. sq. non Keratinized
<b>Taste bud</b>	Absent	On top	On sides	On sides & top
<b>Associated glands</b>	-----	-----	Serous Von Ebner glands	Serous Von Ebner gl.

**b- Mucous and serous acini.**

	<b>Mucous acini</b>	<b>Serous acini</b>
<b>Size</b>	Large	Small
<b>Lumen</b>	Wide	Narrow
<b>Shape</b>	Cuboidal, distinct borders	Pyramidal, indistinct borders
<b>Nuclei</b>	Flat, basal	Rounded, near the base
<b>Cytoplasm</b>	Pale basophilic, vacuolated	Basal basophilic striation, apical acidophilic secretory granules
<b>EM</b>	RER, Golgi, large mucous granules	Extensive basal RER, supranuclear Golgi, apical electron dense granules

**c- Parotid and submandibular glands**

	<b>Parotid gland</b>	<b>Submandibular gland</b>
<b>Capsule</b>	<i>Thick, well developed</i>	<i>Thick</i>
<b>Septa</b>	<i>Thick</i>	<i>Thin</i>
<b>Acini</b>	<i>Purely serous</i>	<i>predominantly serous with few mucous and mixed acini.</i>
<b>Fat cells</b>	<i>Numerous in septa</i>	<i>less</i>
<b>Function</b>	<i>Secretes 25 % of saliva</i>	<i>Secretes 75 % of saliva</i>

**d- Resting and active parietal cells.**

	<b>Resting parietal cells</b>	<b>Active parietal cells</b>
<b>Intracellular canaliculi</b>	Short	Long and wide
<b>Microvilli</b>	Few and short	More and long
<b>Tubulovesicular system</b>	Plenty	Decreased

**e- Duodenum, jejunum and ileum.**

	<b>Duodenum</b>	<b>Jejunum</b>	<b>Ileum</b>
--	-----------------	----------------	--------------



<b>Villi</b>	Broad & <u>numerous</u>	Long	<u>Least in number</u> villi are short or absent over The Peyer's patches
<b>Goblet cells</b>	Few	More	<u>Numerous</u>
<b>Submucosa</b>	Contains Brunner's glands	----- just c.t. with Meissner's plexus as usual	Peyer's patches

**f- Pancreas and parotid gland.**

	<b>PANCREAS</b>	<b>PAROTID</b>
<b>Capsule</b>	Thin	Thick
<b>Trabeculae</b>	Thin and loose	Thick and fibrous
<b>Acini: Serous</b>	Larger and variable shape	Smaller and rounded
	Centro-acinar cells	Absent
<b>Ducts</b>	Relatively few	Numerous
<b>Striated duct</b>	Absent	Numerous
<b>Main duct</b>	Simple Col, Enteroendocrine cells & goblet cell	St sq.non ker.
<b>Islets of Langerhan's</b>	Present	Absent

**g- Cells of large intestinal crypts**

<b>Cell</b>	<b>Colonocytes</b>	<b>Goblet</b>	<b>Enteroendocrine</b>	<b>Stem Cell</b>
<b>LM</b>	Acidophilic cytoplasm brush border, basal oval nucleus	Wide apex, narrow base, basal basophilia and vacuolated apical part	Need silver stain, chromium stain or immunostaining	- Columnar - Present in base of the crypt - Basophilic cytoplasm
<b>EM</b>	Mitochondria, sER, rER, Golgi complex.  - Irregular microvilli - Junctional complex  - Dilated intercellular spaces.	Basal part contains rER, Golgi complex, mitochondria  Apical secretory mucous granules	-Two types: closed and open.  - It contains rER, Golgi complex , mitochondria and basal secretory granules	- Free ribosomes - Little other organelles.
<b>functi on</b>	Water absorption	Secrete mucous to lubricate feces	Secrete hormones	Regeneration of different cells

**h- Fundus & pylorus:**

	<b>Fundus</b>	<b>Pylorus</b>
<b>Mucosa</b>	Contain fundic glands: <ul style="list-style-type: none"> <li>- simple branched tubular</li> <li>- numerous</li> <li>- perpendicular to surface</li> <li>- narrow lumina</li> <li>- narrow gastric pits</li> </ul> -Gastric pits form $\frac{1}{4}$ of thickness of mucosa -lined by surface mucous cells, mucous neck cells, parietal cells, chief cells, stem cells, enteroendocrine cells	Contain pyloric glands: <ul style="list-style-type: none"> <li>- simple branched tubular <u>coiled</u></li> <li>- less numerous</li> <li>- not perpendicular to surface, secretory portions are cut in T.S. &amp; oblique sections</li> <li>- wide lumina</li> <li>- wide deep gastric pits</li> </ul> - Gastric pits form $\frac{1}{2}$ the thickness of mucosa -lined by mucous secreting cells, stem cells & enteroendocrine cells
<b>Submucosa</b>	c.t.	c.t.
<b>Muscularis externa</b>	3 layers: <ul style="list-style-type: none"> <li>- <u>inner oblique</u>,</li> <li>- middle circular</li> <li>- outer longitudinal smooth muscle</li> </ul>	2 layers: - inner circular (greatly thickened forming pyloric sphincter) <ul style="list-style-type: none"> <li>- Outer longitudinal</li> </ul>
<b>Serosa</b>	present	present

i- **Cells of intestinal villi and upper part on crypts**

	<b>Enterocytes</b>	<b>Goblet cells</b>	<b>Enteroendocrine cells</b>
<b>LM</b>	-Tall Columnar cells with apical PAS+ ve brush border Acidophilic cytoplasm and basal oval nuclei	Wide apex, narrow base, basal basophilia and vacuolated apical part	Not seen by H&E Need silver stain, chromium stain or immunostaining
<b>EM</b>	<ul style="list-style-type: none"> <li>- Numerous apical microvilli</li> <li>- Glycocalyx (cell coat) containing brush border enzymes: disaccharidase and dipeptidase.</li> <li>- Actin filaments inserting into a terminal web</li> <li>- Junctional complex</li> <li>- Lateral interdigitations</li> <li>- <b>sER</b></li> <li>- rER, Golgi, mitochondria.</li> </ul>	Basal part contains rER, Golgi complex, mitochondria  Apical secretory mucous granules	-Two types: closed and open.  - It contains rER, Golgi complex, mitochondria and <b>basal</b> secretory granules

j- **Cells on lower part of intestinal crypts:**

	<b>Crypt base columnar cells</b>	<b>Paneth cells</b>	<b>Microfold cells</b>
<b>Site</b>	Base of crypts	Base of crypts in groups below the stem cells	In ileum over Peyer's patches

<b>LM</b>	Basophilic cytoplasm, Vesicular nucleus	Deep basal basophilia, Apical acidophilic zymogen granules, Basal vesicular nucleus..	Cannot be distinguished because they are very thin & stretched
<b>EM</b>	abundant <u>free ribosomes</u> , little Golgi, little mitochondria.	Well-developed basal rER , Supranuclear Golgi, Abundant mitochondria, Apical electron dense granules.	<ul style="list-style-type: none"> <li>• <u>Free borders</u>: Show Small number of microvilli.</li> <li>• <u>Basal parts</u>: show numerous basal membrane invaginations, forming <u>pockets</u> containing intraepithelial lymphocytes &amp; macrophages.</li> <li>• <u>Lateral borders</u>: joined with the neighboring columnar cells by junctional complexes.</li> <li>• Cytoplasm: contains <u>few lysosomes</u>.</li> </ul>
<b>functions</b>	Stem cells they undergo mitosis to give rise to enterocytes and goblet cells every 4-6 days.	a) Protein secreting cells that secrete: 1- antibacterial lysozyme. 2- Defensin protein. b) Regulate bacteria flora of intestine	Antigen transporting cell

**k. Cells of fundic gland:**

<b>Stem cells</b>	<b>Mucous neck cells</b>	<b>Parietal (Oxyntic) cells</b>	<b>Chief (zymogenic) cells</b>	<b>Enteroendocrine cells</b>
<b>Site:</b> isthmus (stem cell niche).	Neck region of fundic gland	In upper half of gastric glands (mainly in neck), fewer in the base.	<b>Base</b> of fundic gl.	Scattered.
<b>LM:</b> Basophilic cytoplasm.  Vesicular nucleus	Apical pale basophilic foamy mucinogen granules <b>(PAS positive).</b> (less than surface mucous cells).	- Rounded or pyramidal. - <b>Deeply acidophilic</b> - Nucleus: rounded central vesicular, may be binucleated	Cytoplasm: basal deep basophilia, apical acidophilic zymogen granules - Nucleus: rounded, basal, vesicular	Not seen by H&E  Seen by <b>silver</b> (argentaffin cells), <b>chromium</b> (enterochromaffin cells), and by <b>immunohistochemistry</b>
<b>EM:</b> abundant <u>free ribosomes</u> ,	- Well-developed basal rER, Golgi apparatus	- <b>Abundant mitochondria</b> (giving the acidophilia in LM).	- Apical secretory zymogen granules Supranuclear Golgi complex	<b>2 types:</b>  <b>Open type:</b> reach the lumen

little Golgi, little mitochondria, .....	- Apical secretory vesicles.	- <b>Intracellular canaliculi</b> : deep invagination of the apical plasma membrane that shows <b>microvilli</b> . - <b>Tubulovesicular system</b> surrounding the canaliculi, acting as a reservoir. - Little RER, small Golgi complex	Abundant basal rER - Abundant mitochondria	and have apical microvilli (chemoreceptors).  <b>Closed type</b> : do not reach the lumen.  Both have <b>basal secretory granules</b> .
Have a high rate of <b>mitosis</b> ----- renewal and repair of the epithelium of gastric mucosa.	Secrete <b>soluble mucous, less alkaline</b> than the surface mucous secreting cells to intermingle with the stomach content.	<b>HCL &amp; intrinsic factor secretion</b>	secrete <b>pepsinogen</b> ( <i>activated by acidity of stomach into <b>pepsin</b></i> ), and  <b>+ lipase</b> enzyme.	Secrete different hormones, affecting the gut functions & have different names (EC cells , ECL cells, .....)